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**ORIGINAL ARTICLE****1**

Paired arcuate and modified circular keratotomy in keratoconus

Quawasmi SA

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Paired arcuate and modified circular keratotomy in keratoconus

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Abstract

AIM: To reduce astigmatism, increase corneal volume and improve visual acuity.

METHODS: A retrospective, single-surgeon, single-center, clinic-based study of a surgical procedure on twenty-four eyes of fourteen patients diagnosed with stage III or stage IV keratoconus. Paired arcuate keratotomy coupled with modified circular keratotomy was performed at a single center by a single surgeon as an outpatient procedure with local anaesthetic in a minor surgery room. Modified circular keratotomy was performed 7 mm from the pupillary center with depth of incision ranging between 70% and 90% of corneal thickness. Arcuate keratotomy was performed 2.5 mm from the pupillary center with the depth of incision at 90% of corneal thickness. Angular length of the arcs ranged between 60° and 120° depending on the astigmatic power of the cornea.

RESULTS: Astigmatism decreased in 87.5% of the 24 treated eyes, increased in 8.33% and did not change in 4.17%. Corneal volume increased in 91.66% of the 24 eyes and decreased in 8.34%. Visual acuity improved in 100% of the eyes; there was a mean improvement of 59% from preoperative visual acuity, 8.34% of the treated eyes reaching a visual acuity of 1.0 (20/20) with correction. No complications occurred during or

after surgery. No suturing was performed and there was no rupturing at incision sites. There was statistical significance difference between pre.sph against post.sph ($P = 0.001$). Also between pre.cyl against post.cyl ($P = 0.005$), there was no significance difference between pre.axis against post.axis ($P = 0.05$).

CONCLUSION: Paired arcuate keratotomy coupled with modified circular keratotomy should be considered as an intervention before performing keratoplasty.

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Key words: Arcuate keratotomy; Circular keratotomy; Keratoconus; Astigmatism; Keratotomy; Bader procedure; Ectasia

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INTRODUCTION

Keratoconus is a non-inflammatory, progressive, bilateral thinning disease of the cornea^[1,2]. It is characterized by the development of a corresponding protrusion with an apex often located centrally or in an inferior eccentric position^[1,2]. It is also characterized by corneal surface irregularity, astigmatism and ectasia accompanied by myopia and refractive amblyopia^[3]. In the mildest cases, *i.e.*, stages I and II, eyeglasses or contact lenses can be used to correct vision^[1].

As the disorder progresses to stage III or IV, eyeglasses or the various kinds of contact lenses may no longer correct the disorder sufficiently^[1]. If keratoconus is not corrected, keratoplasty may be required^[1]. Intracorneal rings, collagen cross-linking, and many other methods have been used to arrest the progression of keratoconus

before it progresses to later stages^[1]. Two techniques or interventions to address keratoconus are arcuate keratotomy^[1,4-6] and circular keratotomy^[1,7-9].

A new procedure, which I have named the Bader procedure, couples paired arcuate keratotomy^[10] with a modified form of circular keratotomy^[1,7-9] to induce the cornea to correct its topography through its natural healing process^[11,12]. Paired arcuate keratotomy was examined in 1988 as a possible method for the reduction of astigmatism^[10]. Subsequently, the use of an arcuate keratome to make transverse arcuate corneal incisions was examined as a method of correcting astigmatism, and successful use of the instrument in five consecutive eyes with naturally occurring astigmatism was reported^[4,6] used standard arcuate keratotomy in postkeratoplasty eyes, regardless of preoperative astigmatism, and concluded that standard treatment, irrespective of preoperative cylinder, has a linear effect on the reduction of postkeratoplasty astigmatism. Patients with higher degrees of preoperative astigmatism experienced greater reductions in astigmatism following the treatment. Hoffart *et al*^[5] concluded that arcuate keratotomy performed with the Hanna arcitome was effective in reducing postkeratoplasty astigmatism. The device enabled safer, easier arcuate incisions compared with manual incision techniques. However, it was also concluded that predictability and efficacy could be improved by a more accurate nomogram.

Circular keratotomy has been performed using a trephine blade and suturing^[13], some procedures being coupled with the implantation of rings^[7]. In a study of three patients, Leccisotti^[14] concluded that circular keratotomy increased corneal curvature and worsened keratoconus and could therefore not be recommended. However, Krumeich *et al*^[8] reported that circular keratotomy provided significant reduction in astigmatism, improved best spectacle-corrected visual acuity, and stabilized astigmatic changes in most eyes, although some eyes showed limited benefit. Eyes with greater preoperative astigmatism appear to be more likely to benefit from the procedure than those with lower preoperative astigmatism. Circular keratotomy also resulted in reasonable clinical results in the treatment of stage I and II keratoconus^[8].

MATERIALS AND METHODS

All patients in the study came to the clinic after examination by other doctors who had diagnosed them with stage III or stage IV keratoconus. Diagnosis was confirmed by the examiner on their first visit and classified using the Krumeich classification (Table 1). All patients had been informed by other doctors that they required keratoplasty to treat their condition. Preoperative tracking for disease progression was not applicable in this situation because the patient had already progressed to a stage requiring treatment. All operations occurred within 1 wk of their visit to the clinic.

Patient examination and operating techniques

The clinical examination at our center included the E-test,

refractometer, retinoscopy, direct and indirect ophthalmoscopy, sagittal cornea examination, subjective and objective visual acuity tests, ultrasound examination, glare test and Oculus Pentacam topography. Preoperative and postoperative sphere and cylinder measurements were recorded (Table 2), but were not analyzed as dependent variables. The primary outcome variables measured were uncorrected and spectacle-corrected acuity, refractive error with the pupil dilated and undilated, corneal shape, corneal pachymetry, and corneal indices measured by Oculus Pentacam topography (Table 3).

This approach to treatment addresses the irregularity of the cornea and the steepness of the meridian by positioning the circular keratotomy 7 mm from the pupillary center and two arcuate keratotomy incisions 2.5 mm from the pupillary center at 90° to the steepest meridian. Figure 1A represents the angular circumference of the cornea. Figure 1B illustrates one possible calculation and location for the paired arcuate incisions. Figure 1C illustrates the combination of the arcuate keratotomy and modified form of circular keratotomy. Notice that the paired arcuate incisions are of the same angular length.

A Hanna arcitome with micrometric diamond knives was used. The procedure was a modified form of circular keratotomy which used microincision but no trephining. The depth, length, and location of the incisions were predetermined according to topographic readings. Two micrometric diamond knives, each with a width of 1.0 mm and thickness of 0.150 mm, were mounted 180° apart. Local anesthetic was applied and corneal thickness was measured by ultrasonic pachymetry at 1640 m/s. Three measurements were taken in the area where incisions were proposed, and the mean thickness was calculated. The blades were then set to the correct depth. Great care was taken to avoid exposure of the cornea to direct illumination as this affects its thickness during the operation^[15,16].

The diameter of the free cornea zone was marked and the angular length of the cut was set. Dextran solution and antibiotic were applied to moisten the surface of the cornea before, during, and after the incisions. The instrument was then placed on the eye and the blades were inserted in the cornea.

The arcuate incisions were placed at a radial distance of 2.5 mm from the pupillary center on each side of the steepest axis, creating an arcuate incision diameter of 5.0 mm, and were made in one continuous sweep. The arcuate incisions were of a defined angular length extending from 60° to 120° and were determined by the degree of astigmatism. Angular length was calculated using the values of the dioptric power of the cornea, and the difference between K1 and K2 readings obtained in the Pentacam analysis of the cornea. Angular length is directly related to astigmatic corneal power (Table 3).

The seating depth of the blade was adjusted with a calibrated screw mechanism at the top of each knife. The depth of the arcuate incisions ranged between 70% and 90% depending on the thickness of the cornea and corneal power. An area of low corneal power received a deeper incision than an area of high corneal power be-

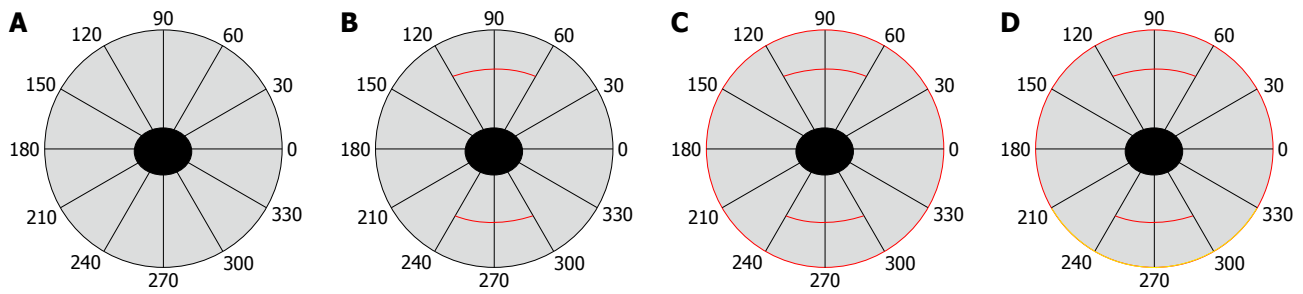


Figure 1 The treatment addresses the irregularity of the cornea and the steepness of the meridian. A: Represents the angular circumference of the cornea; B: Illustrates one possible calculation and location for the paired arcuate incisions; C: Illustrates the combination of the arcuate keratotomy and modified form of circular keratotomy; D: The yellow arc marks the area of low corneal power from 210° to 330° and indicates an area of 90% incision depth, while the incision in the red area would be at a depth of 70%.

cause corneal volume tends to increase more in the area of the deepest incision and less in the area of shallow incision; this allows the cornea to reform or restructure to nearly equalized corneal power. Factors that affect the actual depth of the incision in the cornea are the pachometric readings and location of the corneal thickness. Following the arcuate incisions, the modified form of circular keratotomy was performed.

A full circular incision of 360°, with no corneal suction, was made in one continuous movement at 30°/s. The depth of the circular incision ranged between 70% and 90% depending on the thickness of the cornea and corneal power. For example, if corneal power was low from 20° to 200°, this area would receive an incision of depth 90% and the remaining part would receive an incision of depth 70%. If corneal power was low from 60° to 130° this area would receive an incision of depth 90% and the remaining part an incision of depth 70%. In Figure 1D, the yellow arc marks the area of low corneal power from 210° to 330° and indicates an area of 90% incision depth, while the incision in the red area would be at a depth of 70%. At the conclusion of the procedure, antibiotic drops were applied and the eye(s) were covered with shields with no padding.

Immediate after-care undertaken by the patient included collagen capsules (400 mg) every night before bed coupled with vitamin C (5000 mcg), because vitamin C assists in the pump action of potassium to create pressure equilibrium, reducing haze and facilitating the synthesis of collagen^[17].

G-pilocarpine (2%) drops, which provide the benefit of a parasympathomimetic effect on the epithelial cells, miosis, and maintenance of the anterior chamber pressure so that it is not affected by diurnal variation in intraocular pressure^[3,13], were administered every 3 h during the daytime for the first 6 mo. The refractive power of the eye changes during the first 6 mo of the postoperative period, and the drops were reduced or stopped depending on the improvement in edema. If there was still evidence of edema, the drops were continued for another 6 mo.

Follow-up and postoperative examinations

Follow-up on patients was conducted by phone call to ad-

dress patient concerns only. If during the patient follow-up telephone interviews there were reports of iatrogenic effects, patients would have been asked to see a local physician in their home country and have reports sent to our clinic. No iatrogenic effects were reported. All patients in the study were from other countries in the Middle East region and returned within 11-13 mo for a 1-year post-operative check-up, at which time data were collected. Patients declined to return for follow-up visits during the first year for economic reasons. Insurance in Jordan does not cover many operations in the field of ophthalmology. Patients were, however, informed that they would need to return for a 6-mo and 12-mo follow-up. During post-operative examinations, patient data were collected using the E-test, refractometer, retinoscopy, direct and indirect ophthalmoscopy, sagittal cornea examination, subjective and objective visual acuity tests, ultrasound examination, glare test and Oculus Pentacam tomography and numeric values.

RESULTS

Astigmatism decreased in 87.5% of the 24 treated eyes, increased in 8.33%, and did not change in 4.17%. The percentage decrease in astigmatism ranged between 0% and 92% of the preoperative reading, with a mean decrease of 39% from the original astigmatic reading. The percentage increase in astigmatism ranged from 9% to 20%, with a mean increase of 15% from the original astigmatic reading (Table 3).

Corneal volume increased in 91.66% of treated eyes. The mean increase in corneal volume was 8% of the original corneal volume. Corneal volume decreased in 8.34% of treated eyes. The mean decrease was 8% of the original corneal volume (Table 3).

Visual acuity improved in 100% of treated eyes. There was a mean improvement of 59% from the original visual acuity readings in all treated eyes. Two of the treated eyes (8.34%) improved to a visual acuity of 1.0 (20/20) with assistance (Table 3).

DISCUSSION

The Operating procedure is based on the findings of the

Table 1 All patient cornea power pre and post operation

Case		Gender	Age (yr)	Eye	Date of operation	Pre operation (corneal power in clockwise 360 degree)										Post operation (corneal power in clockwise 360 degree)										Year			
1	F	29	OD	2007-04-15	33.4	34.5	33.4	37.3	45.1	51.6	54.8	54.5	52.1	48.2	43.5	37.8	51.6	48.8	47.2	48.8	52.3	55.7	58.4	59.9	59.4	58.6	58.1	57.3	2011-12-03
2	M	24	OS	2007-11-04	39.7	39.3	40.0	41.1	42.6	43.8	44.6	44.6	43.3	40.8	39.8	39.9	41.1	41.6	41.4	41.6	43.0	44.8	47.2	49.3	49.9	48.5	45.6	42.6	2011-12-18
3	M	22	OD	2007-10-21	41.9	38.7	36.2	36.5	39.5	44.7	46.8	49.1	46.6	44.9	41.9	40.7	39.9	38.7	37.1	37.2	40.2	45.0	49.1	48.6	46.9	45.3	43.6	40.7	2008-03-16
4	F	26	OD	2007-02-11	43.3	42.3	42.1	42.3	45.2	48.2	49.1	48.9	45.7	43.9	42.9	43.7	47.0	44.0	41.8	42.1	46.2	52.4	57.0	58.8	57.3	54.1	53.2	52.4	2011-02-27
5	M	40	OD	2007-11-05	46.7	43.1	39.1	42.0	49.6	55.0	56.8	55.6	51.7	50.2	47.0	46.1	54.4	52.5	52.2	56.0	60.3	65.9	69.5	68.6	69.0	63.7	62.7	61.3	2010-03-09
6	M	22	OD	2007-06-11	39.1	38.6	37.4	38.0	40.9	43.8	44.8	44.0	40.3	38.7	38.0	38.6	37.8	37.2	37.1	38.4	41.6	45.2	48.0	49.0	46.5	42.6	40.2	38.8	2011-06-08
7	M	27	OD	2007-07-11	51.3	50.7	43.3	43.1	47.1	50.8	53.0	54.6	54.4	54.1	54.2	53.8	55.8	55.0	54.4	54.2	55.8	57.5	60.2	61.4	60.8	56.6	58.9	60.0	2010-05-04
8	M	21	OD	2007-12-11	54.7	47.5	43.0	41.6	45.9	54.3	59.4	60.6	55.2	54.3	52.5	52.0	55.2	53.3	57.9	51.3	52.1	55.7	61.2	64.0	63.7	63.1	61.4	59.9	2010-12-19
9	M	24	OD	2007-11-21	41.2	40.5	39.2	39.4	43.2	48.5	50.8	52.4	51.0	49.3	46.1	43.0	42.7	41.0	44.0	48.5	53.4	57.7	60.3	62.4	60.9	62.3	59.3	53.0	2009-05-31
10	M	40	OD	2007-07-12	41.0	38.4	35.6	38.0	42.7	49.2	51.2	56.6	56.6	55.1	51.1	45.5	48.8	47.3	47.5	50.2	54.2	60.2	64.5	67.6	67.5	65.7	63.4	59.9	2011-01-17
11	M	35	OD	2007-04-12	45.4	43.3	39.6	38.0	40.8	43.3	43.8	45.3	45.8	46.3	46.2	46.3	46.0	44.0	42.9	43.5	47.1	52.0	56.1	57.5	55.9	53.1	51.2	48.8	2011-10-15
12	M	23	OD	2007-10-12	41.3	40.8	38.6	39.5	44.3	44.4	43.0	46.0	47.0	46.0	44.6	42.6	49.9	47.9	47.1	47.9	50.7	55.4	58.5	58.5	55.7	52.2	51.0	51.3	2010-12-23
13	M	32	OD	2007-11-12	35.1	37.4	33.4	37.8	42.2	49.2	51.9	55.8	55.9	52.0	44.6	39.7	53.7	51.0	50.5	52.5	58.4	62.0	66.3	70.8	67.4	65.6	65.2	62.4	2009-11-14
14	F	36	OD	2007-11-12	38.4	37.4	38.2	41.1	44.2	48.7	50.9	50.0	48.4	46.3	42.9	41.5	41.9	33.6	40.1	44.5	50.3	56.2	60.7	62.9	62.5	59.0	54.8	51.5	2011-03-22
15	F	33	OD	2007-12-12	37.9	37.0	36.9	40.3	43.8	46.6	47.7	47.1	45.3	43.7	42.4	40.2	47.5	45.8	46.7	49.3	52.6	56.8	59.5	59.7	59.4	55.2	53.3	52.3	2010-07-12
16	M	26	OD	2007-12-12	40.9	39.8	39.3	40.8	44.6	48.0	49.4	49.2	45.7	43.0	41.7	41.3	45.8	44.8	44.1	44.8	49.8	55.0	58.6	59.8	57.6	53.0	48.2	46.7	2011-03-09
17	F	28	OD	2007-12-17	54.3	51.0	47.9	47.2	49.2	51.3	53.6	55.4	55.0	53.4	55.4	54.1	62.5	60.1	58.0	57.8	69.6	62.1	64.7	66.1	65.1	64.8	64.1	64.5	2009-10-21
18	M	42	OD		40.4	41.4	39.4	44.5	48.0	56.0	57.4	57.8	53.6	48.5	46.9	44.2	43.2	45.0	48.1	45.7	52.6	57.9	58.3	57.1	53.1	51.5	48.1	46.7	2008-04-11
19	M	31	OS	2007-12-26	42.9	38.5	39.9	42.2	46.8	51.3	53.3	52.1	47.8	43.4	41.2	40.0	40.6	40.4	43.2	45.6	48.3	52.1	52.9	53.1	49.9	46.9	45.2	43.9	2010-07-04
20	M	33	OD	2008-05-01	38.3	36.6	34.2	35.8	39.7	45.2	47.7	47.5	44.3	42.0	39.9	39.1	47.1	43.2	42.5	44.8	47.7	52.5	55.7	57.0	56.7	55.5	53.3	52.2	2009-07-07
21	M	31	OD	2008-07-01	32.1	36.5	41.5	48.2	57.5	52.8	54.1	55.0	53.8	48.3	42.9	38.2	57.5	53.5	50.3	54.0	60.7	67.4	71.1	71.3	71.0	69.2	63.3	60.7	2011-01-26
22	F	27	OD	2008-09-01	45.5	43.8	41.0	39.3	41.2	43.8	46.0	47.5	42.7	48.2	47.1	46.0	50.5	47.0	45.1	46.9	50.5	54.0	56.8	59.2	59.7	57.4	56.5	56.4	2010-12-21
23	M	31	OD	2008-01-13	43.0	42.0	40.9	46.6	54.8	53.0	53.9	60.3	52.9	53.4	50.8	45.1	49.9	47.8	48.4	50.6	54.6	59.1	57.2	58.3	57.0	55.9	58.2	57.3	2010-07-17
24	M	28	OD	2008-01-14	38.3	36.2	35.4	36.5	39.2	41.1	42.8	44.1	43.7	42.4	40.5	38.5	47.5	44.9	43.8	44.1	47.1	51.2	54.1	55.9	55.7	53.2	50.7	50.1	2001-01-11
25	M	19	OD	2008-02-20	37.3	36.7	35.7	36.1	38.5	41.2	44.4	46.7	44.9	42.6	40.6	39.0	47.2	45.0	42.5	40.7	41.5	46.4	52.7	55.5	56.3	54.5	53.2	52.3	2009-09-04
26	F	29	OD	2008-12-03	46.6	41.1	40.1	42.1	47.0	51.0	54.3	56.2	57.4	56.1	54.0	52.3	60.6	59.4	56.3	56.0	58.0	61.6	63.6	64.8	64.4	61.7	58.6	59.0	2009-03-08
			OS		38.8	40.6	42.2	43.9	47.5	50.4	51.2	48.3	42.1	37.9	37.2	37.3	44.1	47.8	51.5	52.7	54.9	57.2	59.8	60.3	58.8	55.9	50.7	47.1	

27	F	36	OD	2008-03-18	43.7	41.2	38.9	38.5	41.6	45.0	45.9	45.4	44.5	45.5	45.2	44.6	44.5	43.4	38.2	40.0	43.9	47.0	46.0	43.8	46.8	46.2	46.8	46.0	2008-04-11
28	F	39	OD	2008-03-18	45.9	45.4	43.6	41.6	41.6	42.6	43.6	43.6	42.0	41.1	41.6	44.1	46.7	45.7	43.6	42.0	42.4	44.2	45.8	45.7	43.9	43.0	44.1	45.1	2010-10-10
29	M	38	OS	2008-03-30	39.0	39.4	39.7	41.6	44.2	46.1	48.0	47.3	44.6	41.5	39.5	39.2	38.8	39.3	41.4	42.5	45.0	49.6	54.2	58.0	58.4	55.6	50.3	44.9	2009-06-20
30	M	27	OD	2008-07-04	38.9	37.0	37.3	41.5	44.7	54.8	52.5	56.2	49.7	46.5	44.7	40.6	37.2	36.5	39.1	46.0	3.8	62.3	66.4	67.8	67.4	63.4	56.9	50.2	2009-09-05
31	F	47	OS	2008-07-04	42.1	46.9	52.1	55.7	57.0	56.0	55.2	52.0	46.1	41.5	40.3	39.3	41.6	45.0	51.9	57.1	61.4	63.4	65.9	68.2	67.1	62.7	56.8	49.9	2011-12-07
32	M	26	OD	2008-08-04	50.7	47.9	45.4	41.2	45.8	49.6	50.9	50.5	51.2	51.4	51.1	49.0	52.3	53.4	54.3	56.8	58.5	60.4	61.7	61.0	59.3	57.1	54.8	54.2	2009-06-05
33	M	28	OD	2008-04-30	41.2	37.3	38.0	36.7	42.3	48.3	55.1	53.4	53.4	54.0	50.4	45.7	58.6	57.9	49.0	50.3	62.2	66.2	57.5	57.6	60.0	61.3	49.3	65.6	2009-03-16
34	F	39	OS	2008-04-05	54.9	64.9	57.0	51.0	47.9	51.5	62.5	53.7	56.6	56.4	62.9	65.3	56.9	53.4	50.8	47.7	44.1	43.3	45.8	50.7	52.5	53.0	55.4	55.5	2010-10-24
35	M	27	OD	2008-05-05	46.7	45.5	42.6	43.4	47.6	52.4	53.8	54.7	54.5	53.2	52.4	49.3	57.0	54.9	52.8	53.4	55.4	58.8	61.9	62.5	61.3	58.8	58.5	59.3	2011-05-23
36	F	42	OD	2008-05-15	42.5	41.7	41.6	41.0	42.1	43.1	43.6	45.5	45.5	45.7	45.3	44.2	45.1	44.6	44.9	46.1	47.3	49.2	50.9	51.7	51.8	50.0	49.6	49.3	2009-07-10
37	M	35	OS	2008-05-18	38.9	39.7	41.5	43.5	46.0	47.7	47.6	46.6	44.3	41.5	39.8	38.7	43.2	43.8	44.8	46.6	48.6	50.6	52.3	53.4	53.0	51.6	49.1	46.2	2009-07-06
38	M	25	OS	2008-05-24	39.3	41.3	42.8	45.8	48.0	47.7	45.0	44.6	44.1	41.8	39.7	38.8	42.8	44.2	47.4	49.8	51.6	43.6	56.2	55.8	56.7	57.3	53.9	49.5	2011-04-30
39	F	23	OD	2008-07-06	42.2	41.1	39.8	41.2	45.4	51.1	53.2	52.3	47.6	45.2	42.9	42.3	47.1	46.6	47.4	50.0	54.6	59.1	62.1	62.0	58.2	56.2	53.4	51.2	2010-05-15
40	M	24	OS	2008-06-22	43.3	43.6	45.2	46.3	49.0	52.9	53.4	49.6	44.5	40.3	40.1	42.9	49.7	50.8	52.3	53.0	55.5	57.0	60.4	61.2	58.9	54.6	50.3	48.1	2011-09-21
41	F	34	OD	2008-05-07	43.8	43.5	41.7	42.0	42.5	45.6	48.1	50.6	49.9	48.7	47.4	45.8	51.1	50.5	51.0	52.6	55.9	59.6	62.2	62.3	61.3	59.4	57.4	55.6	2010-12-21
42	M	28	OS	2008-06-07	43.9	45.9	48.5	49.9	50.2	50.5	50.0	48.4	46.1	44.6	45.4	43.5	56.3	56.8	57.0	57.5	58.2	58.9	60.0	60.7	60.0	58.6	57.4	56.5	2010-06-03
43	M	30	OD	2008-07-15	40.7	40.7	40.0	40.8	43.8	46.5	48.2	48.8	45.9	43.7	41.2	41.2	40.6	42.8	42.9	43.8	47.3	52.8	57.0	57.8	55.0	50.8	47.4	45.2	2009-02-23
44	M	27	OD	2008-07-15	38.3	36.7	34.9	36.6	39.0	42.7	45.4	47.0	50.4	50.1	45.7	41.1	49.1	47.9	46.9	48.2	49.9	51.7	54.3	55.1	54.7	55.6	55.9	54.1	2009-02-23
45	F	31	OD	2008-07-16	44.7	45.4	47.8	48.4	48.0	45.5	45.9	42.6	41.8	42.6	46.1	46.9	53.8	54.4	53.6	52.2	53.3	55.9	55.9	53.6	49.6	45.8	44.1	46.4	2011-07-03
46	M	19	OS	2008-07-30	36.4	36.8	42.1	45.8	47.5	54.6	55.8	56.6	50.9	44.7	39.1	36.1	51.0	51.5	52.9	54.6	56.9	59.4	62.6	64.7	65.5	64.2	61.5	58.2	1991-01-01
47	M	23	OS	2008-07-30	44.7	44.9	43.2	42.3	42.7	43.1	43.5	42.8	41.8	40.8	41.9	45.0	44.9	44.5	43.6	42.8	42.8	43.1	43.7	44.1	44.0	43.2	42.1	41.9	2009-07-25
48	F	36	OS	2008-03-08	38.9	41.0	42.9	44.8	47.5	48.0	48.4	46.9	44.1	41.1	38.8	38.1	41.9	43.1	44.1	46.3	48.3	50.2	51.0	52.3	52.4	51.1	48.3	45.1	2009-07-20
49	F	34	OD	2008-12-08	42.1	39.6	38.5	40.8	44.4	48.0	48.0	48.7	46.6	44.5	42.1	40.6	41.1	41.2	45.4	48.2	51.4	56.5	60.3	62.6	60.7	58.9	57.8	55.8	2010-04-17
50	M	25	OD	2008-12-08	41.0	41.9	42.8	44.3	46.4	47.2	47.7	45.9	43.2	40.2	38.7	39.3	40.3	42.1	46.1	49.8	52.1	54.4	56.8	58.5	58.7	56.5	2.5	48.0	27-07-2010
51	F	30	OD	2008-08-17	38.7	39.5	40.7	43.2	45.1	47.7	48.1	46.0	42.6	39.3	38.0	37.6	40.5	42.6	45.5	47.9	49.9	52.2	54.4	55.4	53.3	51.0	46.9	43.7	2011-06-07
52	F	38	OD	2008-08-14	58.1	61.1	60.5	60.1	59.7	58.9	58.6	57.4	54.2	51.7	49.6	50.6	56.7	59.0	60.2	59.8	59.6	60.4	60.9	62.3	62.4	60.5	54.6	53.0	2011-01-08
53	M	24	OD	2008-08-16	38.2	35.6	35.6	37.7	40.9	43.5	44.5	45.3	43.0	40.9	37.5	37.2	45.8	45.7	47.8	52.2	56.7	61.0	63.9	65.0	62.7	57.8	54.5	51.6	2009-08-10
54	F	27	OD	2008-08-17	43.1	41.7	40.2	41.2	44.3	47.4	49.7	50.2	48.4	46.5	44.5	43.8	46.2	46.1	45.2	48.6	51.1	55.4	57.4	56.6	59.9	57.1	51.4	47.2	2009-08-04
55	F	47	OD	2008-08-18	42.2	41.5	41.4	43.3	48.9	53.7	54.6	52.9	50.2	48.4	45.6	44.3	57.1	55.3	54.6	54.5	54.7	56.0	55.9	56.5	56.3	55.7	58.2	59.6	2010-07-21
56	F	49	OS	2008-08-27	39.3	41.5	44.8	47.5	50.4	50.5	52.0	54.6	50.6	44.1	40.5	37.9	53.6	53.6	54.2	56.8	58.7	62.9	66.3	68.3	67.1	63.4	60.4	58.6	2009-06-10
57	F	26	OD	2008-08-30	38.5	37.4	35.8	36.6	39.9	44.2	46.8	48.1	48.6	48.1	44.8	40.8	48.1	44.1	40.8	40.1	43.2	48.2	52.8	56.2	56.9	55.3	53.3	53.3	2009-07-16
58	M	24	OD	2008-09-22	41.0	40.6	40.7	39.9	41.2	43.8	45.2	46.2	45.3	44.7	43.3	40.9	54.3	52.4	50.1	49.1	49.6	50.9	52.2	54.2	55.6	55.9	56.2	56.7	2011-11-20
			OS		42.2	42.9	44.4	45.6	45.8	44.6	43.8	42.5	41.7	41.2	41.1	41.4	54.7	55.4	54.7	53.2	50.5	49.5	48.7	48.1	48.4	48.7	48.5	48.5	

59	M	48	OD	2008-09-21	39.2	37.5	36.9	38.4	43.6	48.9	50.7	51.7	51.5	50.1	47.6	43.2	52.0	49.2	47.9	49.1	52.6	58.2	62.4	64.6	64.9	63.9	61.5	59.0	2009-03-21
60	M	41	OD	2008-09-23	37.3	41.1	44.3	45.6	48.2	52.5	53.7	53.3	48.7	43.7	39.9	37.0	38.3	40.6	44.6	46.4	48.6	53.2	56.7	56.8	52.1	47.2	43.3	38.4	2010-02-24
61	M	22	OD	2008-09-27	43.6	44.3	44.0	43.8	44.5	46.3	48.1	46.7	44.2	42.6	42.2	43.0	42.3	43.6	44.0	44.5	45.4	45.8	48.3	49.6	49.7	48.1	46.2	44.4	2009-07-26
62	M	44	OD	2008-10-26	44.2	42.9	40.9	40.8	44.5	46.4	49.2	50.8	50.2	49.6	48.7	46.4	57.2	54.8	51.3	51.0	53.1	55.6	58.2	60.5	59.0	56.9	57.0	57.5	2009-05-31
63	F	30	OD	2008-10-29	42.5	42.6	42.9	43.3	43.8	44.1	44.9	44.2	42.7	41.9	41.4	42.0	47.7	48.0	47.1	45.3	45.1	47.2	49.6	51.2	51.8	50.8	48.4	46.5	2009-04-25
64	F	39	OD	2008-10-29	48.1	48.8	49.4	49.2	49.7	50.5	50.8	50.6	49.7	49.1	48.6	48.5	48.9	49.5	49.5	49.6	49.9	50.5	50.1	49.9	49.4	49.5	49.4	49.0	2009-04-25
65	M	22	OD	2008-12-23	41.5	39.2	40.8	45.6	49.8	55.0	56.2	56.1	57.4	53.7	50.4	48.9	44.3	43.3	47.2	45.1	47.6	53.5	55.5	55.8	62.1	56.6	50.9	50.0	2011-03-28
66	M	29	OD	2009-05-01	41.0	39.4	38.6	39.6	42.0	46.1	48.6	49.6	48.9	46.9	43.7	41.4	46.4	44.5	42.9	44.8	48.5	53.0	57.0	58.9	57.6	53.8	51.4	50.0	2011-04-09
67	M	28	OD	2009-06-01	41.3	40.7	44.0	47.5	49.2	50.0	48.2	45.6	41.8	39.3	39.1	40.4	49.5	53.9	57.1	58.2	58.9	60.8	62.0	62.0	59.9	55.0	49.1	44.9	2011-03-05
68	M	22	OD	2009-10-02	50.6	49.8	48.0	46.6	48.2	50.5	50.6	49.3	49.1	50.0	51.5	51.8	49.1	49.2	47.8	47.4	49.3	51.5	51.9	49.8	49.1	50.0	51.5	51.1	2009-10-19
69	M	25	OD	2009-10-02	48.7	49.0	49.5	50.2	49.3	49.7	50.8	51.3	49.9	47.8	48.1	48.4	49.6	50.8	51.5	50.5	50.0	50.5	51.8	51.9	48.8	47.9	47.9	48.8	2009-10-19
70	M	34	OS	2009-02-23	36.6	35.2	36.1	41.1	46.6	51.9	55.2	57.5	59.8	57.0	53.2	48.6	41.1	39.7	41.7	45.7	51.2	55.8	58.2	58.8	57.6	54.7	52.0	49.4	2009-10-19
71	M	26	OD	2009-02-22	41.3	39.5	38.8	39.4	41.9	45.0	47.2	49.1	49.8	49.8	48.8	47.6	45.1	42.7	41.6	43.6	46.9	50.4	52.8	53.6	52.9	51.6	51.4	51.0	2009-02-22
72	M	33	OD	2009-01-03	57.6	58.3	59.2	60.8	54.1	68.1	72.4	73.8	72.3	67.3	61.9	59.8	56.5	55.7	55.4	56.1	50.2	66.6	69.4	72.0	71.4	67.3	62.2	58.9	2010-08-14
73	M	23	OD	2008-06-01	43.0	45.1	46.5	48.0	50.2	52.8	54.9	55.6	53.7	49.5	45.0	40.5	47.6	51.3	54.9	56.9	57.8	60.1	61.8	61.9	59.5	54.8	49.3	44.0	2010-08-01
74	F	33	OS	2009-03-03	38.2	37.4	43.6	48.5	50.1	50.6	50.5	50.3	52.7	51.3	47.5	45.4	43.7	46.7	52.0	52.3	52.6	51.8	51.8	50.6	49.6	51.8	50.0	49.8	24-01-2010
75	F	28	OS	2009-05-04	36.3	37.6	41.6	46.6	51.3	54.8	57.4	59.1	58.0	54.0	49.0	44.1	46.3	49.3	52.0	53.7	55.3	57.0	58.9	60.8	59.4	64.4	50.0	46.5	2010-03-21
76	F	24	OD	2009-04-13	44.2	43.0	40.9	40.5	41.2	43.7	46.2	46.9	46.1	45.1	44.2	44.5	47.0	45.3	43.7	42.7	44.3	47.4	50.3	52.1	52.4	51.1	49.6	48.5	2010-01-23
77	M	29	OD	2009-04-20	42.7	43.0	43.6	45.2	46.7	48.3	47.9	45.7	43.1	41.2	40.7	41.3	43.4	45.3	47.0	49.1	51.3	54.0	55.3	54.0	52.9	50.5	46.3	43.5	2010-07-08
78	F	35	OD	2009-04-21	40.5	39.4	39.3	41.1	43.8	47.5	49.9	50.4	48.9	46.7	44.9	43.5	43.8	42.6	43.2	44.1	47.0	51.4	53.8	53.4	51.8	49.9	48.2	47.2	2009-10-11
79	F	27	OD	29-04-2009	41.1	41.7	41.6	42.1	42.9	44.2	46.0	47.5	47.3	44.9	42.6	40.7	42.0	43.8	43.8	45.5	46.0	47.2	49.5	51.9	52.2	49.7	46.0	42.9	2011-07-30
80	F	33	OD	2009-10-05	42.1	40.5	40.3	41.7	44.2	48.7	53.1	55.9	57.3	56.5	54.2	51.5	46.0	43.8	44.6	45.5	48.0	51.5	55.9	59.8	60.0	58.2	57.0	54.6	2010-04-03
81	M	31	OD	2009-05-16	44.1	44.7	62.7	79.5	72.4	62.6	67.9	51.2	41.1	43.4	38.2	31.9	48.6	54.2	58.1	60.7	60.3	58.0	55.2	56.1	54.5	51.9	50.1	47.9	2011-03-03
82	F	33	OD	2009-05-18	41.4	39.5	39.8	42.4	46.3	50.3	52.8	53.6	52.0	50.0	49.0	47.6	42.9	40.6	40.4	43.3	47.5	51.9	54.7	55.3	53.9	51.6	50.2	48.8	2011-10-07
83	F	28	OD	2009-05-19	39.6	38.2	39.2	42.4	45.9	49.1	52.4	53.6	52.0	50.0	47.7	45.3	42.3	41.3	40.9	44.2	48.8	52.5	55.4	56.0	54.5	52.9	51.0	48.5	2009-12-28
84	M	32	OD	2009-03-06	40.0	41.7	43.7	46.9	50.1	53.0	54.7	54.5	52.7	49.2	45.2	41.1	42.1	44.5	46.7	48.9	51.1	53.2	56.0	56.3	56.1	53.4	49.9	45.1	2010-12-12
85	M	30	OD	2009-06-06	43.4	43.3	43.0	43.5	45.1	47.7	50.4	52.4	52.3	50.3	47.7	45.0	40.0	42.0	42.5	42.8	44.0	45.4	48.5	48.8	44.0	44.0	43.1	41.9	2010-07-10
86	M	25	OD	2009-04-07	42.3	41.9	42.1	42.3	43.5	45.0	47.0	48.7	48.7	47.3	45.7	43.9	42.7	42.7	42.6	42.0	42.7	44.5	46.8	48.6	49.3	48.0	46.0	43.9	2020-01-08
87	M	21	OD	2009-07-07	42.1	42.2	41.8	41.5	41.1	41.3	41.4	41.4	41.7	41.8	41.5	41.1	40.9	43.2	42.7	42.0	41.5	41.8	42.4	42.9	42.6	42.1	41.6	42.0	2020-01-08
					58.8	57.6	56.1	56.8	57.6	60.4	63.1	63.6	62.7	60.5	58.8	58.2	52.8	52.7	55.0	58.6	65.2	73.7	80.2	82.1	77.7	70.5	63.3	57.1	
					55.0	48.8	47.1	49.4	52.1	57.7	60.8	63.0	64.0	61.9	61.5	61.5	52.3	51.0	49.0	50.9	54.2	58.8	63.7	64.7	64.9	69.4	62.4	60.5	
					59.5	57.9	56.4	56.9	60.0	62.9	65.2	64.0	62.4	59.2	59.1	59.0	58.1	56.4	55.7	56.6	60.7	64.7	66.9	66.7	64.8	61.3	60.8	59.4	
					53.1	55.2	58.4	57.9	59.0	60.3	62.0	64.3	63.9	60.7	56.4	52.2	54.4	55.6	55.5	55.7	57.6	57.6	60.2	54.0	66.5	65.4	62.8	57.4	

88	M	20	OS	2009-11-07	40.0	43.0	45.5	46.0	48.9	50.9	51.9	52.8	52.0	49.4	45.7	42.1	42.2	45.1	47.6	48.4	50.3	52.6	54.6	56.0	54.9	51.8	47.6	44.0	2010-07-06	
89	F	24	OD	2009-11-07	39.7	38.6	38.2	38.1	38.1	40.4	42.9	45.8	48.2	49.7	49.7	49.1	46.6	42.0	39.2	37.8	37.6	39.5	41.0	43.7	46.2	48.3	49.6	50.2	49.1	2011-06-22
90	M	16	OD	2009-12-07	56.6	58.4	55.3	50.6	45.6	43.0	42.5	42.2	44.3	45.9	46.4	46.4	48.9	59.3	60.7	59.5	56.8	52.7	49.6	48.1	45.9	46.9	47.8	50.2		
91	M	23	OD	2009-12-07	38.6	39.1	39.1	40.9	44.7	49.4	52.8	53.8	52.8	49.7	46.7	44.7	40.2	42.1	43.3	46.2	50.9	54.0	57.1	57.0	54.6	51.5	47.6	45.6	2010-03-10	
92	M	40	OD	2009-07-13	42.6	46.0	50.9	52.5	51.8	50.3	49.4	47.4	47.2	43.3	42.6	42.2	43.5	48.3	53.7	52.2	48.4	54.8	54.8	51.7	50.2	51.7	50.2	2011-12-11		
93	M	22	OD	2009-07-14	47.2	49.5	50.7	49.8	50.6	52.8	54.5	54.7	54.6	52.9	49.9	47.9	50.6	51.7	52.9	53.3	52.6	48.1	39.9	37.8	41.0	43.1	47.7	48.8	2010-03-22	
94	M	22	OD	2009-07-15	44.9	42.6	40.9	41.8	44.2	48.1	52.0	54.1	56.2	57.1	54.8	51.7	44.9	42.1	41.7	43.0	47.8	51.8	55.2	58.3	60.7	61.1	57.7	54.4	2010-02-11	
95	F	17	OD	2010-10-01	42.4	45.6	50.2	54.7	58.4	60.9	59.8	56.8	52.3	47.0	42.8	40.9	42.0	45.9	50.7	56.3	60.2	61.4	61.0	58.6	53.9	50.2	46.4	43.7		
96	M	43	OD	2009-07-21	43.2	46.3	48.8	49.6	50.6	52.0	53.8	55.2	53.9	51.6	47.4	42.6	45.3	49.2	52.7	53.5	54.8	56.6	58.9	60.6	60.0	56.7	51.1	46.4	2011-05-11	
97	M	31	OD	2009-07-26	54.7	55.1	54.6	55.7	57.7	59.6	59.9	59.4	57.6	55.5	63.9	53.2	56.2	55.7	54.2	56.6	57.9	58.4	60.6	61.5	61.1	59.2	55.8	54.9		
98	F	24	OD	2009-07-29	45.5	46.8	47.3	46.4	45.3	44.6	45.0	45.9	45.5	45.1	45.0	44.4	53.3	52.2	50.9	50.1	51.6	54.6	57.3	57.7	58.3	56.0	53.9	2010-07-17		
99	F	36	OD	2009-07-29	41.6	39.6	38.7	40.3	43.5	47.5	51.1	53.4	53.3	51.4	48.2	46.9	44.4	42.6	41.4	41.5	43.4	47.7	50.8	52.7	53.2	52.4	50.2	48.8	2011-03-03	
100	M	22	OD	2009-07-28	49.3	50.8	53.5	54.8	56.3	58.0	59.5	59.2	58.8	55.5	51.2	48.5	52.7	54.5	56.5	53.8	54.2	54.2	55.2	54.2	55.2	54.5	52.8	48.1		
101	F	22	OD	2009-02-08	40.9	41.5	44.1	47.5	50.4	52.6	53.9	53.1	52.6	51.3	49.0	41.9	43.6	47.0	50.9	54.6	57.6	60.3	60.0	57.2	54.5	52.8	50.5			
102	M	34	OD	2009-03-08	42.8	43.1	44.1	45.4	47.1	48.4	49.3	49.7	49.7	48.9	47.4	45.8	43.0	43.4	44.1	45.4	47.1	48.5	49.4	49.8	49.6	48.5	47.2	45.7	2010-02-03	
103	M	22	OD	2009-07-28	39.7	38.3	38.6	40.4	43.2	45.7	47.7	48.5	48.2	46.5	44.7	43.1	39.1	38.2	38.8	42.3	47.5	52.6	55.7	56.7	56.5	55.3	54.1	51.9		
104	M	24	OD	2009-08-19	39.8	40.8	44.0	45.4	46.8	48.1	48.9	49.5	48.5	46.0	43.3	40.3	41.7	44.9	47.6	50.3	52.1	53.9	54.6	54.1	53.6	51.1	47.6	43.7	2010-04-17	
105	M	28	OD	2009-01-09	44.5	47.9	52.6	56.1	57.8	55.5	55.1	48.5	40.7	44.0	42.3	41.8	42.6	64.6	62.2	61.4	60.9	59.0	59.5	58.1	55.4	52.0	49.9	51.4		
106	M	17	OD	2009-09-15	45.1	44.8	44.4	44.4	45.1	45.9	46.2	46.1	45.6	44.9	44.4	44.7	46.1	45.5	44.9	45.6	46.8	47.6	47.5	46.5	45.4	44.2	44.1	44.6	2009-07-28	
107	M	42	OD	2009-09-29	44.9	45.6	45.4	44.6	44.3	45.1	45.9	46.4	46.6	45.9	44.8	43.9	46.6	46.3	45.7	45.0	44.4	44.9	45.5	46.4	46.9	46.6	45.7	45.2		
108	F	24	OD	2009-06-10	44.0	42.6	42.8	43.9	45.2	48.2	51.5	54.8	56.6	55.9	53.4	50.5	45.6	43.6	43.3	44.2	46.7	49.7	53.1	55.6	56.8	56.3	54.4	52.3	2011-07-14	
109	M	34	OD	2009-10-20	42.6	43.6	45.4	48.1	51.5	54.7	57.6	58.1	55.6	51.7	47.8	44.7	42.5	43.5	45.7	48.5	52.2	55.7	58.1	58.7	57.0	52.9	48.6	45.4		
110	F	28	OS	2009-10-24	47.6	43.7	39.6	37.9	39.5	43.0	46.3	48.8	49.9	49.8	50.4	51.5	49.0	46.1	44.3	45.2	48.0	50.9	52.9	54.5	53.3	52.3	52.1	52.1	2011-11-01	
111	M	36	OS	2009-01-12	41.0	42.1	42.7	43.1	44.8	47.0	49.0	49.2	47.6	45.1	41.4	39.0	45.0	46.2	48.1	48.2	48.9	50.9	52.9	54.7	53.4	50.0	45.7	43.3		
112	M	27	OD	2009-09-12	42.7	42.7	41.5	40.6	40.5	42.0	43.2	39.7	36.5	37.1	39.1	38.7	43.3	42.7	43.1	44.0	42.6	42.0	44.5	44.7	41.2	39.3	38.8	39.9	2011-09-29	
113	M	28	OD	2009-12-13	58.6	56.8	55.2	53.6	54.9	57.6	60.3	61.6	61.4	59.8	58.5	57.8	64.8	61.2	60.8	58.9	59.3	62.1	57.4	49.5	38.7	63.2	65.9	64.4		
114	M	24	OD	2009-08-19	54.2	51.3	46.5	44.9	46.3	46.9	46.0	47.5	49.5	54.2	58.2	61.6	53.3	57.3	54.5	49.7	49.8	50.2	47.6	45.0	45.0	52.9	56.5	60.5	2010-10-05	
115	M	28	OD	2009-01-09	39.9	37.4	39.6	41.3	43.8	48.2	52.6	55.6	57.4	58.1	56.4	51.4	37.9	37.4	38.5	43.3	48.4	52.3	54.9	57.3	60.9	61.6	56.9	52.2	2011-03-23	
116	M	17	OD	2009-09-15	74.7	75.6	60.2	61.9	61.9	63.3	63.0	65.2	62.1	59.4	60.2	56.2	62.6	58.3	71.3	65.8	58.9	58.3	55.9	60.0	60.6	60.1	59.2			
117	M	42	OD	2009-09-29	39.9	38.6	39.1	41.3	44.4	48.7	52.6	54.6	53.7	51.2	48.9	46.2	39.4	37.3	38.3	41.7	46.2	52.4	56.3	58.7	58.5	54.1	50.8	47.4	2010-05-12	
118	F	24	OD	2009-06-10	43.8	42.3	41.7	42.0	42.3	40.6	43.6	49.5	52.0	53.2	53.1	51.1	58.9	56.3	52.6	48.5	45.1	40.4	40.9	47.3	52.0	55.3	55.5	56.3		
119	M	34	OD	2009-10-20	34.2	34.4	35.6	39.5	45.4	50.7	55.2	56.4	53.7	49.6	45.1	41.0	39.7	39.5	41.3	44.7	50.0	54.7	56.6	57.6	55.5	50.9	46.8	43.7	2011-03-31	
120	M	42	OD	2009-09-29	38.9	43.1	47.6	52.3	56.5	60.0	63.7	64.0	60.4	53.3	47.0	44.0	43.3	44.4	45.6	48.9	53.3	57.3	62.3	62.7	60.3	56.1	51.1	47.5		
121	F	28	OS	2009-10-24	44.8	55.0	54.4	57.2	58.1	50.9	41.7	43.5	45.2	44.7	47.0	45.7	58.5	61.3	61.1	57.1	57.6	59.1	56.3	51.1	46.8	42.9	44.9	48.8	2010-04-06	
122	M	34	OD	2009-10-20	57.2	53.9	52.4	48.5	42.5	39.4	42.7	48.0	46.7	48.0	48.6	45.8	60.0	59.2	56.4	52.8	46.7	45.1	51.2	58.9	60.0	55.9	55.0	52.8		
123	M	34	OD	2009-10-20	37.8	40.9	49.3	40.0	57.2	69.4	51.8	60.4	64.8	57.1	47.8	50.0	49.4	45.8	42.7	43.2	46.7	51.6	55.3	57.8	59.1	58.1	56.4	55.5	2010-07-13	
124	F	28	OS	2009-10-24	41.9	46.3	52.1	62.1	59.3	50.8	48.3	53.4	54.3	47.4	39.4	35.6	39.5	43.2	47.9	51.7	54.6	57.2	59.2	59.8	57.5	53.5	48.0	43.7		
125	M	34	OD	2009-10-20	39.7	38.3	37.5	35.7	34.8	34.3	35.6	37.3	39.3	41.0	42.0	41.9	41.5	39.1	37.0	36.1	33.9	33.8	34.8	36.4	38.5	40.1	41.1	41.2		
126	F	28	OS	2009-10-24	37.5	38.0	40.5	41.7	41.8	40.7	39.0	36.5	34.4	34.3	34.1	35.6	38.9	40.2	40.6	41.2	41.7	41.0	39.0	36.2	34.7	33.5	32.6	33.5		
127	M	36	OS	2009-01-12	45.6	49.3	54.4	56.8	58.6	61.1	62.9	64.0	61.8	55.1	48.0	43.8	45.9	49.2	52.5	55.5	57.4	59.8	62.2	62.8	61.0	57.2	50.7	46.2	2010-07-25	
128	M	27	OD	2009-09-12	50.6	54.2	55.5	56.3	56.9	57.3	57.5	57.2	55.5	52.8	49.7	47.0	51.1	53.7	55.6	55.6	56.0	56.6	57.3	57.8	56.2	53.5	50.9	47.9	2011-06-26	
129	M	28	OD	2009-12-13	38.1	37.4	38.2	40.4	42.9	46.5	49.1	49.3	47.6	45.0	44.3	42.4	43.2	43.7	45.9	50.3	55.4	60.7	63.6	64.7	61.4	58.0	54.0	50.3	2011-10-04	
130	M	28	OD	2009-12-13	37.3	39.1	40.7	42.8	45.1	47.1	48.7	49.3	48.2	45.1	41.5	38.4	39.8	43.4	45.8	40.2	51.3	55.7	59.3	61.2	59.5	53.8	47.6	41.8		
131	M	28	OD	2009-12-13	30.9	40.3	42.2	45.1	48.0	43.7	50.9	51.0	50.2	48.1	45.5	43.2	43.0	42.5	42.2	43.1	45.6	48.0	49.3	50.0	49.6	49.0	47.8	46.4	2011-04-12	
132	OS				40.0	41.2	42.6	44.4	46.5	48.1	49.8	48.4	47.6	46.7	44.5	42.1	40.9	42.0	43.7	45.2	46.9	48.6	49.2	49.4	48.8	47.2	44.8	42.3		

114	M	24	OD	2009-12-14	40.0	40.7	40.4	40.6	41.4	42.2	43.2	43.9	44.6	44.1	43.2	42.3	41.2	40.9	40.7	41.6	42.8	43.9	45.3	45.9	45.5	44.5	43.7	43.0	2010-06-27
			OS		39.6	41.4	43.4	44.9	46.4	48.4	50.1	50.9	50.1	47.8	44.6	41.3	40.8	42.3	44.9	45.5	47.6	50.7	53.7	55.7	54.0	50.8	46.6	43.0	
115	M	33	OD	2010-09-01	54.9	53.9	53.3	56.9	61.0	67.5	71.0	71.3	68.8	65.4	61.5	59.1	57.6	56.0	57.3	62.2	66.7	69.9	71.0	70.6	68.2	65.3	63.8	61.6	2011-12-31
			OS		38.6	38.9	41.2	44.9	48.5	53.5	56.9	58.8	59.6	57.5	53.6	48.8	42.6	44.0	47.7	50.5	54.2	58.0	61.7	63.7	64.0	61.8	55.6	50.8	
116	F	19	OD	2010-10-01	51.9	49.1	46.3	46.5	48.1	52.7	57.1	59.2	58.6	57.0	55.1	54.9	59.4	56.7	55.6	55.9	58.6	63.1	65.7	65.3	63.4	60.6	58.0	57.9	2010-07-17
			OS		50.2	51.0	51.7	50.1	51.4	55.2	59.2	62.4	63.2	60.6	56.2	51.8	56.1	55.4	55.8	55.1	55.8	60.3	65.2	68.4	69.4	65.8	61.2	56.2	
117	M	26	OD	2010-01-27	38.4	36.1	35.7	39.4	42.7	46.9	51.9	55.2	56.2	54.9	51.3	47.6	39.8	38.2	39.5	41.7	44.0	48.8	52.8	55.9	57.6	56.3	53.2	49.2	2011-04-26
			OS		37.8	39.2	41.5	45.3	49.7	53.4	54.3	54.1	51.1	47.5	44.3	40.9	33.0	39.2	41.1	45.1	49.6	53.5	56.2	55.7	53.3	49.1	45.2	41.8	
118	F	21	OD	2010-02-24	44.1	41.5	42.1	44.7	49.6	54.6	57.3	58.6	56.8	53.7	51.6	50.0	46.0	44.0	43.5	45.5	49.7	54.6	57.5	58.3	56.9	53.8	51.7	50.2	2011-06-25
			OS		50.7	53.1	55.8	57.2	57.6	57.7	58.5	60.0	59.5	58.2	54.4	50.6	53.3	54.8	56.8	57.4	57.1	56.8	57.7	59.8	59.5	57.4	54.6	52.2	
119	M	19	OD	2010-09-02	54.7	53.5	59.3	55.1	52.4	55.5	56.0	56.0	53.4	50.1	54.3	60.8	59.5	57.9	58.7	56.5	56.4	58.1	58.2	57.3	55.5	55.5	55.1	57.0	2010-10-17
			OS		41.4	41.6	41.7	41.1	41.0	41.3	41.5	41.5	41.4	41.7	42.1	42.2	41.6	41.3	41.1	41.0	41.4	42.3	43.0	43.6	43.7	43.5	43.3	42.8	
120	F	45	OD	2010-03-13	39.2	39.9	41.9	44.1	46.0	48.0	49.7	48.9	46.5	44.4	43.1	41.7	39.9	40.5	42.4	44.7	46.5	47.9	49.2	48.4	46.0	44.2	43.0	41.9	2011-09-17
			OS		39.8	39.1	39.5	40.5	42.0	43.6	45.1	44.8	43.4	42.2	41.0	40.9	41.0	40.0	40.4	42.4	44.5	47.6	50.1	50.2	48.6	46.8	45.4	44.4	2011-07-25
121	M	34	OD	2010-04-13	50.7	49.0	47.5	46.4	45.8	46.9	48.6	50.5	51.4	51.2	49.8	48.3	51.2	50.9	50.5	49.7	49.0	49.7	50.6	52.4	53.3	51.6	49.3	48.2	
			OS		41.1	40.9	41.6	42.1	43.3	43.0	40.8	39.5	41.9	44.5	44.3	44.0	39.9	40.6	41.9	43.5	44.9	44.2	43.3	43.6	45.0	45.8	45.1	43.8	2011-10-09
122	M	32	OD	2010-05-07	38.3	38.7	41.6	45.2	47.3	47.7	45.6	43.4	42.2	43.6	44.9	43.5	34.6	35.5	38.9	43.9	49.2	53.5	54.2	54.6	54.6	53.7	50.5	46.0	
			OS		40.4	46.7	51.0	69.3	55.5	59.5	63.5	64.6	60.1	52.1	43.6	35.6	44.5	48.9	51.0	51.3	52.6	56.2	60.1	60.9	58.9	53.6	46.5	40.5	2011-04-04
123	M	26	OS	2010-10-07	46.3	44.6	43.0	42.9	44.0	46.1	48.5	50.5	50.9	50.4	50.4	49.9	44.6	43.5	43.5	45.4	47.9	50.9	53.9	54.6	52.8	50.8	49.5	48.7	2011-02-07
			OS		43.3	44.4	46.2	48.2	49.5	49.7	49.2	48.9	48.7	48.1	47.0	45.7	44.8	46.5	47.8	49.3	50.5	51.3	51.8	52.5	53.2	51.7	49.4	47.6	
125	F	14	OD	2010-07-19	43.4	42.3	41.4	40.9	40.3	41.9	42.2	42.2	42.0	41.7	41.8	41.9	42.8	42.2	42.4	41.9	41.1	42.1	42.8	42.8	42.9	42.1	42.2	42.3	2011-01-27
			OS		44.4	43.7	42.0	41.6	41.7	42.8	41.3	40.7	42.6	43.2	41.8	41.9	44.3	43.5	42.0	41.6	41.9	42.4	42.2	42.1	42.7	41.9	41.0	41.4	2011-01-26
126	M	17	OD	2010-07-19	44.4	44.1	43.4	42.5	42.0	41.8	42.5	43.2	43.5	42.9	42.2	41.8	44.9	44.1	43.0	42.4	42.2	42.1	42.0	42.2	42.4	42.4	41.8	41.8	
			OS		37.5	34.5	36.1	39.7	47.1	56.0	61.6	65.1	66.4	62.0	54.5	48.1	39.2	39.8	43.2	47.6	53.1	58.5	62.8	65.7	64.3	60.1	63.1	47.3	2011-02-15
127	F	29	OD	2010-01-08	34.6	39.1	43.5	49.5	55.4	61.3	66.3	66.4	63.1	69.0	48.6	41.4	37.2	41.3	47.2	51.6	56.3	62.3	65.7	66.4	64.4	59.6	53.5	47.1	
			OS		40.4	40.6	41.8	44.9	48.2	52.7	54.3	58.2	63.9	61.6	54.4	49.9	40.2	41.1	44.1	48.6	52.7	56.0	58.9	60.4	61.2	57.9	63.8	49.7	2011-12-24
128	M	26	OD	2010-09-20	44.5	44.6	44.3	44.2	45.0	46.3	47.3	47.2	46.1	44.5	43.5	43.0	44.5	44.8	44.3	44.2	45.0	46.4	47.3	47.4	46.4	44.6	43.2	42.9	
			OS		40.8	41.7	42.6	43.6	45.7	48.9	52.4	54.4	53.8	50.3	44.8	41.6	41.8	42.6	43.9	43.8	44.7	48.0	52.0	55.6	55.1	51.6	45.8	52.6	2011-05-25
130	M	20	OD	2010-11-21	42.5	41.7	40.0	38.9	39.8	42.2	44.5	46.4	47.1	46.4	44.8	43.5	41.9	41.4	40.4	39.6	40.9	43.8	45.0	46.0	47.3	46.5	44.2	42.9	2011-05-25
			OS		40.8	40.7	41.0	41.3	43.1	45.2	46.9	47.6	46.3	44.1	41.4	39.9	41.1	41.6	41.5	41.7	43.7	46.3	48.5	49.7	48.4	45.5	42.4	40.2	

F: Female; M: Male.

PERK Study Group^[12], which states that the cornea is capable of regenerating cells for an indefinite period because of its ectodermal origin^[18,19]. The natural healing process of the cornea should therefore be able to improve the keratoconic state by addressing any irregularity or steepness of the cornea and myopia.

Immediately after this procedure the cone of the cornea relaxes and visual acuity improves. We have found that the greater the surface tension we can keep on the cornea during the procedure, the easier the procedure is to perform. During the healing process, the patient experiences foggy vision, which develops because of the laying down of keratocytes and edema of the cells^[20].

Absence of edema becomes obvious when the whitish coloration begins to disappear at the areas of incision, visual acuity improves, and the patient reports fewer shadows in vision. Funderburgh's group postulated that multipotent cells are present in the corneal stroma^[11,21], the cornea responds to acute wounds by activating nearby keratocytes, which assume a fibroblastic phenotype and secrete a non-transparent extracellular matrix, and since this regeneration occurs with no disruption of corneal function, it seems likely that the replacement cells arise from progenitor cells. The disappearance of the whitish color also may indicate that CTGF7 (a connective tissue growth factor) is present, creating the transparency necessary for vision^[22].

There also tends to be an increase in corneal dioptric power and the thickness of the cornea in different areas, which causes increased myopia. These changes have been noted in all incisional areas around the circumference of the cornea except the upper nasal portion. A habit that is formed during the progression of keratoconus is squinting

Table 2 Cornea back pre and post operation

Case	Gender	Age (yr)	Eye	Cornea back										Year
				Pre operation					Post operation					
				K1 (D)	K2 (D)	Km (D)	Astig (D)	Rmin (mm)	K1 (D)	K2 (D)	Km (D)	Astig (D)	Rmin (mm)	
1	M	21	OD	-6.7	-7.9	-7.2	1.2	4.51	-6.7	-7.9	-7.3	1.2	4.25	2010-11-21
1	M	21	OS	-6.5	-7.8	-7.1	1.2	4.44	-6.5	-7.8	-7.1	1.3	4.47	
2	M	23	OD	-5.4	-7.0	-6.1	1.5	5.27	-5.4	-6.8	-6.0	1.4	5.31	2010-11-21
3	M	22	OD	-11.0	-9.1	-10.0	1.8	2.64	-10.4	-11.0	-10.7	0.6	2.31	2010-09-20
3	M	22	OS	-6.5	-7.1	-6.8	0.6	5.42	-6.6	-7.0	-6.8	0.5	5.36	
4	F	20	OD	-8.3	-9.0	-8.6	0.7	3.16	-8.2	-9.7	-8.9	1.5	3.21	2010-01-08
4	F	20	OS	-9.9	-6.6	-7.9	3.3	3.15	-8.8	-9.5	-9.1	0.7	3.22	
5	M	17	OD	-5.9	-6.6	-6.2	0.7	5.76	-6.0	-6.6	-6.3	0.6	5.74	2010-07-19
5	M	17	OS	-6.0	-6.6	-6.3	0.6	5.89	-6.1	-6.5	-6.3	0.4	5.77	
6	F	14	OD	-6.0	-6.6	-6.3	0.6	5.86	-5.9	-6.6	-6.2	0.7	5.91	2010-07-19
7	M	37	OD	-7.3	-7.3	-7.3	0.0	4.90	-7.5	-7.4	-7.4	0.1	5.06	2010-07-13
7	M	37	OS	-7.7	-6.9	-7.3	0.8	4.91	-7.6	-6.9	-7.2	0.7	4.91	
8	M	26	OS	-8.1	-11.1	-8.4	3.0	2.70	-7.6	-10.6	-8.8	3.0	3.01	2010-10-07
9	M	32	OD	-6.4	-5.7	-6.0	0.7	6.19	-6.5	-5.6	-6.0	0.9	6.07	2010-05-07
9	M	32	OS	-6.9	-5.4	-6.1	1.5	5.54	-7.5	-6.3	-6.9	1.1	4.95	
10	F	45	OD	-6.5	-5.4	-5.9	1.1	5.28	-6.5	-5.2	-5.8	1.3	5.21	2010-03-13
11	M	21	OD	-8.1	-9.3	-8.7	1.2	3.48	-8.3	0.5	-8.9	1.3	3.62	2010-02-24
11	M	21	OS	-9.8	-10.5	-10.1	0.8	3.14	-9.8	-10.7	-10.2	0.9	3.27	
12	F	26	OD	-10.8	-12.7	-11.7	1.9	2.00	-10.7	-12.3	-11.4	1.6	2.62	2010-01-30
13	M	26	OD	-6.5	-7.9	-7.1	1.5	4.00	-7.6	-8.1	-7.9	0.5	3.57	2010-01-27
14	F	19	OD	-9.4	-10.6	-8.9	1.2	3.55	-8.3	-10.1	-9.1	1.8	3.58	2010-10-01
14	F	19	OS	-9.5	-10.7	-10.1	1.3	3.29	-8.4	-10.3	-9.3	1.8	3.41	
15	M	33	OD	-11.2	-12.7	-11.9	1.5	2.59	-12.2	-11.2	-11.6	1.0	2.63	2010-09-01
15	M	33	OS	-8.7	-7.9	-8.3	0.8	3.98	-9.4	-9.7	-9.6	0.3	3.49	
16	M	30	OD	-6.5	-6.9	-6.7	0.4	5.30	-6.3	-7.1	-6.7	0.8	5.09	2009-12-14
16	M	30	OS	-7.0	-7.7	-7.3	0.7	4.67	-7.2	-8.1	-7.6	0.9	4.19	
17	M	27	OD	-7.2	-7.8	-7.5	0.6	4.37	-7.4	-7.7	-7.5	0.4	4.18	2009-12-13
17	M	27	OS	-7.1	-7.4	-7.3	0.3	4.66	-7.2	-7.4	-7.3	0.1	4.34	
18	M	27	OD	-6.3	-6.6	-6.5	0.3	5.27	-6.9	-7.8	-7.3	0.9	4.55	2009-09-12
18	M	27	OS	-6.3	-6.5	-6.4	0.2	5.15	-6.7	-7.2	-7.0	0.5	4.58	
19	M	36	OS	-9.6	-11.3	-10.4	1.6	2.83	-10.6	-11.3	-10.9	0.8	2.88	2009-01-12
20	F	27	OS	-10.8	-12.0	-11.4	1.2	2.59	-10.5	-11.4	-11.0	0.9	2.85	2009-10-24
21	M	34	OD	-6.0	-5.7	-5.8	0.3	6.51	-5.7	-5.9	-5.8	0.2	6.47	2009-10-20
21	M	34	OS	-5.6	-6.0	-5.8	0.4	6.41	-5.6	-5.7	-5.6	0.1	6.25	
22	F	24	OD	-8.5	-9.5	-8.9	1.1	2.96	-9.4	-10.6	-10.0	1.2	2.94	2009-06-10
22	F	24	OS	-7.6	-8.9	-8.2	1.3	3.23	-8.9	-9.0	-9.0	0.2	3.05	
23	M	43	OD	-5.8	-7.5	-6.5	1.7	4.35	-5.7	-8.6	-6.8	2.9	4.26	2009-09-29
23	M	43	OS	-5.2	-8.1	-6.3	2.9	4.13	-5.4	-8.2	-6.5	2.9	4.70	
24	M	26	OD	-6.8	-7.2	-7.0	0.3	3.96	-7.4	-8.6	-7.9	1.2	3.72	2009-09-15
24	M	26	OS	-9.5	-10.4	-9.9	0.9	2.88	-8.7	-9.7	-9.2	0.9	3.17	
25	M	32	OD	-7.8	-8.2	-8.0	0.4	4.21	-8.4	-9.1	-8.7	0.7	3.58	2009-05-09
26	M	28	OD	-7.6	-6.4	-6.9	1.2	4.69	-7.9	-6.9	-7.3	1.0	4.27	2009-01-09
26	M	28	OS	-6.8	-7.2	-7.0	0.5	5.41	-7.6	-7.0	-7.3	0.6	5.05	
27	M	20	OD	-9.5	-10.9	-10.1	1.5	3.13	-10.4	-11.2	-10.8	0.7	3.00	2009-08-19
27	M	20	OS	-6.1	-7.4	-6.7	1.3	4.89	-6.2	-8.5	-7.2	2.4	4.03	
28	M	24	OD	-8.0	-7.9	-8.0	0.1	3.39	-8.0	-8.4	-8.2	0.4	2.96	2009-08-19
28	M	24	OS	-10.2	-10.5	-10.4	0.3	3.25	-10.6	-9.5	-10.0	1.1	3.13	
29	M	34	OS	-4.7	-6.5	-5.5	1.7	5.96	-5.8	-6.5	-6.2	0.7	5.50	2009-03-08
30	F	22	OD	-7.2	-9.2	-8.1	2.0	3.71	-8.4	-9.6	-8.9	1.3	3.59	2009-02-08
30	F	22	OS	-6.4	-8.2	-7.2	1.8	4.17	-7.6	-8.7	-8.1	1.1	3.94	
31	M	22	OD	-8.0	-8.3	-8.1	0.3	3.80	-8.5	-9.6	-9.0	1.0	3.30	2009-01-08
31	M	22	OS	-7.9	-8.3	-8.1	0.4	3.78	-8.1	-8.5	-8.3	0.3	3.79	
32	F	36	OD	-6.1	-6.6	-6.4	0.5	5.84	-6.2	-6.5	-6.3	0.3	5.91	2009-07-29
32	F	36	OS	-6.1	-6.7	-6.4	0.6	5.85	-6.1	-6.5	-6.3	0.3	5.98	
33	F	25	OD	-7.4	-8.1	-7.7	0.6	4.48	-7.3	-8.6	-7.9	1.3	3.66	2009-07-29
33	F	25	OS	-10.8	-13.1	-11.8	2.4	2.22	-11.6	-12.7	-12.1	1.1	2.46	
34	M	31	OD	-7.0	-6.3	-6.6	0.6	4.88	-7.3	-9.0	-8.0	1.7	3.73	2009-07-26
34	M	31	OS	-7.5	-6.4	-6.9	1.1	4.69	-8.4	-7.4	-7.9	1.0	4.03	
35	F	31	OD	-6.2	-6.5	-6.3	0.3	5.78	-6.2	-7.1	-6.6	0.9	5.11	2009-07-25
35	F	31	OS	-6.3	-7.0	-6.6	0.6	5.19	-6.6	-7.6	-7.1	1.0	4.64	
36	M	40	OD	-8.2	-7.4	-7.8	0.8	4.52	-8.1	-9.0	-8.5	0.9	3.86	2009-07-21
36	M	40	OS	7.3	-6.7	-7.0	0.6	5.04	-7.1	-6.6	-6.8	0.5	5.08	
37	F	17	OD	-7.6	-9.3	-8.4	1.6	3.65	-7.7	-9.2	-8.4	1.5	3.77	2009-07-21
37	F	17	OS	-10.4	-11.7	-11.0	1.3	2.63	-9.8	-10.5	-10.2	0.7	2.73	

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38	M	22	OD	-7.3	-8.1	-7.7	0.7	3.59	-7.6	-8.4	-8.0	0.8	3.72	2009-07-15
38	M	22	OS	-6.6	-6.6	-6.6	0.0	5.17	-7.5	-7.1	-7.3	0.4	4.75	
39	M	22	OD	-6.8	-8.4	-7.5	1.6	4.04	-8.5	-9.6	-9.0	1.0	3.62	2009-07-14
39	M	22	OS	-7.5	-9.5	-8.4	2.0	3.53	-8.9	-10.0	-9.4	1.0	3.28	
40	M	40	OD	-8.9	-9.2	-9.1	0.2	3.19	-9.8	-10.2	-10.0	0.4	2.68	2009-07-13
40	M	40	OS	-8.6	-8.9	-8.8	0.3	3.09	-8.2	-10.4	-9.2	2.2	2.70	
41	M	23	OD	-7.3	-8.9	-8.1	1.6	3.82	-8.4	-9.4	-8.9	1.1	3.35	2009-12-07
41	M	23	OS	-7.5	-8.4	-7.9	0.9	4.50	-6.6	-8.0	-7.2	1.4	4.32	
42	M	16	OD	-7.4	-8.6	-8.0	1.2	3.77	-8.1	-8.8	-8.5	0.7	3.90	2009-12-07
42	M	16	OS	-6.0	-6.4	-6.2	0.5	5.96	-5.9	-6.4	-6.2	0.5	5.79	
43	F	24	OD	-6.8	-7.4	-7.1	0.7	4.59	-6.6	-7.7	-7.1	1.0	4.56	2009-11-07
43	F	24	OS	-6.2	-7.4	-6.7	1.2	4.29	-6.6	-7.4	-6.9	0.8	4.53	
44	M	21	OD	-6.9	-8.7	-7.7	1.8	3.85	-6.9	-8.7	-7.7	1.8	3.90	2009-11-07
44	M	21	OS	-8.2	-9.8	-8.9	1.6	3.05	-8.5	-10.0	-9.2	1.5	3.28	
45	M	21	OD	-8.6	-10.3	-9.4	1.7	3.32	-9.5	-9.4	-9.4	0.1	3.06	2009-07-07
45	M	21	OS	-9.4	-10.1	-9.8	0.7	3.59	-9.7	-9.1	-9.4	0.7	3.47	
46	M	25	OD	-8.7	-8.2	-8.4	0.5	3.84	-11.4	-8.4	-9.7	3.0	2.82	2009-04-07
46	M	25	OS	-7.5	-10.1	-8.6	2.6	3.44	-5.7	-8.5	-6.8	2.7	3.64	
47	M	31	OD	-5.9	-6.0	-5.9	0.2	6.15	-5.9	-6.2	-6.0	0.3	6.16	2009-06-06
47	M	31	OS	-5.8	-6.1	-6.0	0.3	6.32	-5.9	-6.0	-5.9	0.1	6.35	
48	M	32	OD	-6.9	-8.3	-7.5	1.4	4.18	-7.1	-8.7	-7.8	1.6	3.78	2009-03-06
48	M	32	OS	-6.9	-6.3	-6.6	0.6	4.70	-6.4	-6.6	-6.5	0.3	4.83	
49	M	42	OD	-6.2	-6.3	-6.2	0.1	5.28	-6.6	-6.4	-6.5	0.2	5.19	2009-05-27
49	M	42	OS	-6.6	-6.2	-6.4	0.4	5.22	-7.0	-6.2	-6.6	0.8	5.11	
50	M	31	OD	-6.3	-7.0	-6.6	0.7	4.80	-6.0	-6.9	-6.4	0.9	4.43	2009-05-16
50	M	31	OS	-6.3	-5.9	-6.1	0.4	5.28	-6.3	-5.9	-6.1	0.4	5.21	
51	F	33	OD	-7.5	-6.6	-7.0	0.9	4.57	-7.0	-8.4	-7.6	1.3	3.83	2009-10-05
51	F	33	OS	-6.4	-7.9	-7.1	1.5	4.07	-7.2	-8.2	-7.7	1.0	3.94	
52	F	27	OD	-7.2	-8.3	-7.7	1.1	4.46	-7.3	-8.4	-7.8	1.1	4.28	2009-04-29
52	F	27	OS	-7.6	-8.2	-7.9	0.7	4.30	-7.8	-8.1	-8.0	0.3	4.38	
53	F	35	OD	-8.4	-7.6	-8.0	0.7	4.15	-9.0	-8.4	-8.7	0.5	3.87	2009-04-21
53	F	35	OS	-5.1	-14.1	-7.4	9.1	-18.16	-9.7	-10.7	-10.2	1.0	3.06	
54	M	29	OD	-7.7	-6.8	-7.2	1.0	4.71	-7.5	-8.4	-8.0	0.9	4.15	2009-04-20
54	M	29	OS	-6.9	-6.1	-6.4	0.8	5.26	-7.4	-7.0	-7.2	0.4	5.06	
55	F	24	OD	-6.7	-8.0	-7.3	1.3	4.01	-7.1	-8.3	-7.7	1.2	3.74	2009-04-13
55	F	24	OS	-7.3	-7.7	-7.5	0.3	3.75	-7.8	-8.5	-8.2	0.7	3.67	
56	F	28	OD	-6.3	-5.5	-5.9	0.8	5.10	-6.4	-5.5	-5.9	0.9	5.17	2009-05-04
56	F	28	OS	-7.4	-6.8	-7.1	0.6	4.54	-7.9	-8.8	-8.3	1.0	4.16	
57	F	33	OD	-6.0	-6.5	-6.2	0.5	5.60	-5.9	-6.6	-6.2	0.7	5.49	2009-03-22
57	F	33	OS	-6.9	-5.5	-6.1	1.3	5.43	-6.9	-8.0	-7.4	1.1	4.43	
58	M	23	OD	-9.0	-10.8	-9.8	1.8	2.52	-9.5	-10.4	-10.0	0.9	2.81	2008-06-01
58	M	23	OS	-7.2	-8.1	-7.6	0.9	4.05	-8.7	-7.6	-8.1	1.1	3.58	2009-03-03
59	M	33	OD	-6.3	-8.1	-7.1	1.7	4.30	-7.9	-9.5	-8.6	1.6	3.62	2009-01-03
59	M	33	OS	-11.2	-9.0	-9.9	2.2	2.93	-11.0	-10.2	-10.6	0.8	2.87	
60	M	26	OD	-6.7	-8.2	-7.4	1.5	4.24	-7.9	-8.7	-8.3	0.8	4.08	2009-02-22
60	M	26	OS	-7.3	-9.1	-8.1	1.8	3.71	-8.6	-10.0	-9.3	1.4	3.61	
61	M	34	OS	-12.5	-13.1	-12.8	0.6	2.28	-13.5	-12.4	-12.9	1.1	2.05	2009-02-22
62	M	25	OD	-7.5	-8.3	-7.9	0.9	4.11	-7.7	-9.3	-8.5	1.6	3.71	2009-10-02
63	M	22	OD	-8.5	-8.9	-8.7	0.4	3.08	-8.3	-9.2	-8.7	0.9	3.36	2009-10-02
64	M	28	OD	-9.5	-10.6	-10.0	1.1	2.48	-9.6	-10.4	-10.0	0.8	2.77	2009-06-01
64	M	28	OS	-9.8	-10.5	-10.1	0.7	3.09	-9.4	-10.4	-9.9	0.9	3.14	
65	M	29	OD	-8.1	-8.4	-8.2	0.3	3.66	-8.2	-9.1	-8.6	0.9	3.97	2009-05-01
65	M	29	OS	-7.4	-8.0	-7.7	0.6	3.80	-10.0	-8.6	-9.2	1.4	3.63	
66	M	29	OD	-7.6	-8.6	-8.1	1.0	3.67	-7.3	-8.8	-8.0	1.5	3.85	2008-12-23
67	F	39	OD	-6.6	-7.1	-6.8	0.5	5.46	-6.7	-7.2	-6.9	0.4	5.43	2008-10-29
67	F	39	OS	-6.8	-7.4	-7.1	0.5	5.36	-6.9	-7.2	-7.0	0.3	5.38	
68	F	30	OD	-6.8	-7.4	-7.1	0.5	5.26	-6.8	-7.3	-7.0	0.4	5.28	2008-10-29
68	F	30	OS	-7.0	-7.1	-7.1	0.1	5.27	-7.0	-7.3	-7.2	0.2	5.34	
69	M	44	OD	-7.8	-9.4	-8.5	1.6	3.81	-9.2	-9.1	-9.2	0.1	3.93	2008-10-26
69	M	44	OS	-6.5	-7.5	-7.0	1.0	4.93	-8.1	-7.2	-7.6	0.9	4.40	
70	F	27	OD	-6.9	-8.5	-7.6	1.6	3.90	-8.4	-8.7	-8.5	0.3	3.69	2008-07-10
71	M	22	OD	-6.7	-8.4	-7.4	1.6	3.96	-9.5	-9.6	-9.6	0.1	3.26	2008-09-27
72	M	41	OD	-6.1	-6.0	-6.1	0.1	4.50	-7.0	-6.8	-6.9	0.2	4.47	2008-09-23
72	M	41	OS	-6.0	-5.0	-5.5	0.9	5.62	-6.0	-5.3	-5.7	0.7	5.56	
73	M	24	OD	-8.6	-10.3	-9.4	1.6	2.76	-10.0	-10.4	-10.2	0.4	3.25	2008-09-22
73	M	24	OS	-7.2	-7.8	-7.5	0.7	4.27	-7.9	-8.9	-8.4	1.0	4.17	
74	M	48	OD	-10.0	-10.0	-10.0	0.0	3.21	-10.8	-11.9	-11.3	1.1	2.70	2008-09-21
74	M	48	OS	-10.4	-10.6	-10.5	0.2	2.95	-9.8	-10.9	-10.3	1.0	2.93	
75	F	27	OD	-6.9	-8.8	-7.7	1.9	3.78	-7.4	-9.5	-8.3	2.1	3.65	2008-08-30
75	F	27	OS	-7.1	-8.5	-7.7	1.4	3.59	-10.2	-9.0	-9.5	1.2	3.20	
76	F	49	OS	-14.7	-15.3	-15.0	0.6	1.76	-15.7	-16.1	-15.9	0.4	1.60	2008-08-27

77	F	47	OD	-7.9	-9.1	-8.4	1.3	3.78	-8.8	-10.2	-9.5	1.4	3.51	2008-08-18
77	F	47	OS	-11.0	-8.3	-9.5	2.7	2.58	-9.3	-10.2	-9.7	0.9	2.72	
78	M	24	OD	-6.1	-7.2	-6.6	1.1	4.22	-8.4	-9.4	-8.9	0.9	3.48	2008-08-16
78	M	24	OS	-6.8	-0.1	-0.2	6.7	6.85	-9.9	-12.4	-11.0	2.5	2.63	
79	F	38	OD	-6.5	-8.0	-7.2	1.4	3.84	-6.7	-8.5	-7.5	1.8	3.75	2008-08-14
79	F	38	OS	-6.8	-6.1	-6.4	0.7	4.84	-7.4	-6.8	-7.1	0.7	4.59	
80	F	30	OD	-6.1	-7.8	-6.8	1.8	4.37	-7.0	-8.8	-7.8	1.7	3.74	2008-12-08
80	F	30	OS	-10.8	-12.7	-11.7	1.9	2.29	-10.6	-11.4	-11.0	0.7	3.02	
81	M	25	OD	-5.9	-6.6	-6.2	0.7	5.45	-6.2	-7.1	-6.6	0.9	5.04	2008-12-08
81	M	25	OS	-7.4	-6.4	-6.8	1.0	4.56	-8.1	-7.6	-7.8	0.4	4.30	2008-08-17
82	F	35	OD	-7.3	-8.0	-7.7	0.7	4.15	-8.7	-10.1	-9.4	1.4	3.33	2008-12-08
82	F	35	OS	-6.9	-7.7	-7.3	0.8	4.37	-8.7	-10.1	-9.4	1.4	3.33	
83	F	36	OD	-6.6	-7.1	-6.8	0.4	4.79	-6.6	-7.0	-6.8	0.4	4.95	2008-03-08
83	F	36	OS	-7.6	-6.0	-6.7	1.6	4.45	-7.0	-7.4	-7.2	0.4	4.50	
84	M	23	OS	-6.0	-6.7	-6.4	0.6	5.81	-6.0	-6.8	-6.4	0.8	5.56	2008-07-30
85	M	22	OS	-12.3	-7.8	-9.6	4.5	-3.89	-10.8	-12.1	-11.4	1.3	2.71	2008-07-30
86	F	31	OD	-6.6	-7.8	-7.2	1.2	1.20	-6.5	-7.7	-7.1	1.2	4.56	2008-07-16
87	M	27	OD	-7.7	-9.2	-8.4	1.6	3.28	-8.8	-10.4	-9.5	1.6	3.13	2008-07-15
87	M	27	OS	-10.1	-11.8	-10.9	1.6	2.95	-8.3	-10.4	-9.3	2.1	3.32	
88	M	30	OD	-6.8	-8.0	-7.4	1.3	4.21	-7.3	-8.1	-7.6	0.8	3.90	2008-07-15
88	M	30	OS	-6.8	-7.8	-7.2	1.0	4.52	-7.0	-8.3	-7.6	1.4	4.19	
89	M	28	OD	-6.9	-7.7	-7.3	0.8	4.42	-8.0	-8.6	-8.3	0.5	4.09	2008-06-07
89	M	28	OS	-7.6	-7.9	-7.8	0.3	4.22	-8.5	-8.8	-8.7	0.4	3.45	
90	F	34	OD	-9.2	-10.3	-9.7	1.1	3.39	-10.1	-11.2	-10.6	1.0	2.89	2008-05-07
90	F	34	OS	-8.4	-9.7	-9.0	1.3	3.57	-10.5	-11.3	-10.9	0.8	2.96	
91	M	24	OS	-9.8	-10.4	-10.1	0.6	3.15	-9.9	-10.8	-10.4	0.9	3.06	2008-06-22
92	F	23	OD	-7.2	-7.8	-7.5	0.6	4.06	-8.1	-9.2	-8.6	1.0	3.96	2008-07-06
92	F	23	OS	-9.8	-11.3	-10.5	1.5	2.88	-9.6	-11.3	-10.4	1.6	3.00	
93	M	25	OD	-6.6	-7.4	-7.0	0.8	4.84	-6.9	-8.0	-7.4	1.0	4.30	2010-01-03
93	M	25	OS	-8.0	-9.7	-8.7	1.7	3.08	-8.8	-10.2	-9.5	1.4	2.89	2008-05-24
94	M	35	OS	-7.9	-8.8	-8.3	0.9	3.38	-7.6	-9.1	-8.3	1.5	3.39	2008-05-18
95	F	46	OD	-7.0	-6.7	-6.8	0.3	5.27	-7.4	-6.8	-7.1	0.6	5.07	2008-05-15
95	F	46	OS	-8.2	-7.8	-8.0	0.4	4.05	-7.6	-8.0	-7.8	0.4	4.65	
96	M	27	OD	-10.0	-10.6	-10.3	0.6	2.96	-10.2	-10.7	-10.5	0.5	2.89	2008-05-05
97	F	39	OS	-6.2	-2.5	-3.5	3.7	4.78	-6.1	-7.4	-6.7	1.4	3.86	2008-04-05
98	M	28	OD	-10.7	-13.5	-11.9	2.8	2.31	-10.0	-11.6	-10.7	1.6	2.72	2008-04-30
99	M	26	OS	-7.8	-8.8	-8.3	1.0	3.35	-8.6	-9.6	-9.1	0.9	3.29	2008-04-14
100	M	28	OD	-7.6	-9.8	-8.6	2.1	3.65	-9.1	9.8	-9.4	0.7	3.72	2008-08-04
101	F	48	OS	-6.2	-8.5	-7.2	2.3	3.89	-6.6	-9.0	-7.6	2.3	3.58	2008-07-04
102	M	27	OD	-8.9	-11.4	-10.0	2.5	2.56	-9.0	-10.6	-9.8	1.6	2.40	2008-07-04
102	M	27	OS	-12.1	-14.1	-13.0	2.0	2.10	-9.7	-10.7	-10.2	0.9	2.45	
103	M	38	OS	-6.5	-7.3	-6.9	0.8	4.57	-6.9	-7.7	-7.2	-0.8	4.17	2008-03-20
104	F	39	OD	-6.6	-7.5	-7.0	0.9	4.98	-6.4	-7.1	-6.8	0.7	5.07	2008-03-18
105	F	36	OD	-10.0	-10.5	-10.3	0.5	3.00	-11.4	-11.5	-11.4	0.1	2.43	2008-03-18
105	F	36	OS	-6.2	-6.8	-6.5	0.6	5.77	-6.3	-6.8	-6.5	0.5	5.64	
106	F	29	OD	-11.2	-11.4	-11.3	0.2	2.87	-9.9	-11.2	-10.5	1.3	3.33	2008-12-03
106	F	29	OS	-7.8	-7.9	-7.9	0.1	3.85	-8.9	-9.9	-9.4	1.0	3.42	
107	M	18	OD	-6.3	-8.1	-7.1	1.8	4.41	-7.9	-9.2	-8.5	1.3	3.97	2008-02-20
107	M	18	OS	-8.5	-9.5	-9.0	1.1	3.74	-9.1	-10.0	-9.5	0.9	3.50	
108	M	28	OD	-5.9	-7.5	-6.6	1.5	3.97	-7.5	-9.0	-8.2	1.4	3.82	2008-01-14
108	M	28	OS	-11.2	-10.6	-10.9	0.6	2.87	-10.9	-10.2	-10.5	0.7	3.17	
109	M	30	OD	-7.4	-9.0	-8.1	1.6	3.92	-8.8	-9.5	-9.2	0.6	3.91	2008-01-13
110	F	25	OD	-6.9	-9.1	-7.8	2.3	3.72	-8.7	-10.0	-9.3	1.4	3.30	2008-09-01
110	F	25	OS	-6.5	-8.0	-7.2	1.5	4.31	-7.4	-8.6	-8.0	1.1	4.01	
111	M	31	OD	-14.7	-10.1	-12.0	4.6	1.76	-13.8	-15.7	-14.7	2.0	1.74	2008-07-01
112	M	33	OD	-6.9	-8.2	-7.5	1.4	4.00	-8.5	-9.8	-9.1	1.4	3.40	2008-05-01
112	M	33	OS	-9.2	-9.8	-9.5	0.6	3.39	-9.8	-10.3	-10.1	0.5	3.43	
113	M	31	OS	-8.6	-9.3	-9.0	0.7	3.47	-9.6	-10.7	-10.1	1.1	3.12	2007-12-20
114	M	42	OD	-14.2	-15.2	-14.7	0.9	1.75	-14.1	-13.7	-13.9	0.4	2.09	2007-12-18
114	M	42	OS	-7.9	-6.6	-7.2	1.3	4.09	-7.8	-8.0	-7.9	0.3	3.29	
115	F	28	OD	-12.1	-13.3	-12.7	1.1	2.34	-12.0	-13.3	-12.6	1.2	2.40	2007-12-17
115	F	28	OS	-12.6	-11.9	-12.2	0.7	2.65	-11.1	-12.7	-11.8	1.6	2.66	
116	M	26	OD	-6.4	-8.8	-7.4	2.5	3.99	-8.0	-9.1	-8.5	1.1	3.80	2007-12-12
116	M	26	OS	-6.0	-7.1	-6.5	1.0	5.16	-6.1	-7.1	-6.6	1.0	5.26	
117	F	33	OD	-8.5	-9.3	-8.9	0.8	3.04	-9.8	-10.8	-10.3	1.0	2.94	2007-12-12
117	F	33	OS	-6.2	-7.3	-6.7	1.0	5.10	-8.1	-7.0	-7.5	1.1	4.39	
118	F	36	OD	-7.8	-9.4	-8.5	1.6	3.32	-8.4	-9.1	-8.7	0.7	3.51	2007-11-12
119	M	32	OD	-11.9	-14.8	-13.2	3.0	1.80	-12.7	-14.3	-13.5	1.6	2.03	2007-11-12
119	M	32	OS	-7.7	-8.7	-8.1	1.0	3.13	-7.9	-9.2	-8.5	1.4	3.01	
120	M	23	OD	-7.4	-8.6	-7.9	1.3	4.20	-8.0	-9.1	-8.5	1.1	4.11	2007-10-12
120	M	23	OS	-7.1	-8.1	-7.6	1.0	4.45	-8.2	-8.7	-8.4	0.6	4.34	

121	M	26	OD	-6.7	-7.9	-7.3	1.1	4.18	-7.6	-8.4	-8.0	0.9	3.76	2007-09-12
121	M	26	OS	-6.3	-7.0	-6.6	0.7	4.70	-7.4	-6.8	-7.1	0.7	4.57	
122	M	40	OD	-9.1	-10.8	-9.9	1.6	2.98	-10.0	-10.9	-10.4	1.0	2.90	2007-07-12
122	M	40	OS	-9.0	-10.0	-9.4	1.0	3.37	-10.0	-10.9	-10.4	1.0	2.90	
123	M	34	OD	-6.1	-8.1	-7.0	2.0	4.33	-7.5	-9.3	-8.3	1.7	3.82	2007-04-12
123	M	35	OS	-6.1	-6.9	-6.5	0.8	5.15	-6.0	-6.9	-6.4	0.9	5.28	
124	M	28	OD	-6.6	-7.3	-6.9	0.7	4.22	-6.4	-8.0	-7.1	1.6	4.18	2007-03-12
124	M	28	OS	-10.3	-10.8	-10.5	0.6	2.97	-10.3	-10.3	-10.3	0.0	2.94	
125	M	24	OD	-9.2	-10.0	-9.6	0.8	3.09	-9.4	-9.6	-9.5	0.3	3.03	2007-11-21
125	M	24	OS	-7.9	-6.6	-7.2	1.3	4.02	-8.7	-8.8	-8.8	0.1	3.34	
126	M	21	OD	-7.1	-9.3	-8.0	2.2	3.52	-9.6	-3.7	-5.4	5.9	3.17	2007-12-11
126	M	21	OS	-8.3	-9.9	-9.0	1.6	3.43	-7.7	-9.0	-9.3	1.4	3.04	
127	M	27	OD	-9.5	-10.3	-9.9	0.8	2.74	-9.6	-10.7	-10.1	1.1	2.99	2007-07-11
128	M	22	OS	-8.9	-10.4	-9.6	1.5	3.01	-9.9	-9.0	-9.4	0.8	2.95	2007-06-11
129	M	40	OD	-7.6	-8.1	-7.8	0.5	4.30	-8.6	-9.6	-9.1	1.0	3.63	2007-05-11
129	M	40	OS	-8.6	-9.4	-9.0	0.8	3.43	-8.8	-10.1	-9.4	1.3	3.59	
130	F	26	OD	-7.0	-8.2	-7.5	1.2	4.11	-7.6	-9.3	-8.3	1.7	3.67	2007-02-11
130	F	26	OS	-8.5	-9.6	-9.0	1.1	3.30	-9.2	-10.0	-9.6	0.7	3.00	
131	M	22	OD	-6.6	-8.4	-7.4	1.8	4.09	-6.9	-8.5	-7.6	1.7	3.90	2007-10-31
132	M	28	OD	-6.5	-7.4	-6.9	0.9	4.89	-6.5	-7.7	-7.1	1.2	4.72	2007-09-10
133	F	26	OD	-7.2	-7.9	-7.5	0.8	3.70	-8.2	-9.2	-8.7	1.0	3.68	2007-09-16
133	F	26	OS	-8.4	-9.0	-8.7	0.5	3.50	-8.6	-9.0	-8.8	0.4	3.78	
134	M	21	OD	-5.4	-6.5	-5.9	1.0	6.06	-5.4	-6.6	-6.0	1.1	5.93	2007-06-16
134	M	21	OS	-5.6	-6.3	-5.9	0.7	6.16	-5.6	-6.4	-6.0	0.8	6.04	
135	F	29	OD	-8.3	-9.4	-8.8	1.0	3.21	-9.3	-10.4	-9.9	1.1	3.25	2007-04-15
135	F	29	OS	-11.1	-11.5	-11.3	0.4	2.88	-11.3	-11.6	-11.5	0.4	2.88	
136	M	24	OS	-6.0	-6.6	-6.3	0.6	5.11	-6.1	-7.1	-6.6	1.0	5.06	2007-11-04
137	M	43	OS	-14.6	-16.0	-15.3	1.3	1.61	-18.6	-17.0	-17.8	1.6	1.36	2006-11-20
138	F	26	OD	-8.3	-8.7	-8.5	0.4	3.69	-8.4	-8.8	-8.6	0.4	3.71	2006-12-08
138	F	26	OS	-9.4	-10.3	-9.8	0.9	3.47	-9.6	-10.5	-10.0	0.9	3.45	
139	M	27	OD	-7.1	-7.9	-7.5	0.8	4.57	-7.7	-7.2	-7.4	0.6	4.60	2006-06-29
139	M	27	OS	-6.9	-8.2	-7.5	1.3	4.32	-6.9	-8.1	-7.4	1.2	4.57	
140	F	25	OD	-7.3	-8.6	-7.9	1.2	3.60	-7.5	-8.4	-8.0	0.9	4.21	2006-06-28
140	F	25	OS	-6.9	-8.5	-7.6	1.6	3.88	-7.0	-8.7	-7.8	1.8	3.90	
141	M	33	OD	-7.3	-9.0	-8.1	1.7	4.08	-7.6	-8.9	-8.2	1.4	4.08	2005-10-22
141	M	33	OS	-7.4	-8.7	-8.0	1.3	4.12	-7.4	-8.7	-8.0	1.3	4.13	
142	M	22	OD	-8.2	-9.6	-8.8	1.4	3.78	-8.1	-9.5	-8.8	1.3	3.84	2005-08-17
142	M	22	OS	-7.6	-9.5	-8.5	1.9	3.71	-7.6	-9.4	-8.4	1.8	3.67	
143	M	30	OD	-8.2	-8.7	-8.4	0.5	3.85	-9.6	-10.4	-10.0	0.8	3.51	2004-08-24
143	M	30	OS	-9.4	-9.7	-9.5	0.3	2.99	-11.7	-11.8	-11.8	0.2	2.54	
Average				-7.7	-8.5	-10.5	1.2	3.91	-8.2	-8.8	-8.6	1.0	3.87	
SD				2.0	2.1	38.2	1.0	1.83	1.8	2.3	1.8	0.6	0.97	

F: Female; M: Male.

Table 3 Relationship between astigmatic dioptric power and angular length of arcuate incision

Astigmatic dioptric power	Angular length
1D-3D	60
3D-5D	80
5D-7D	100
> 7D	120

to gain better vision. The squeezing that occurs during squinting can cause changes in the regular arrangement of the collagen stroma^[23]. As a result of the procedure there is also an increase in astigmatic power until edema starts to subside.

No suturing is used in our procedure because suturing is known to have a harmful iatrogenic effect^[14]. Ectasia is a known complication after corneal surgery^[16], but has not been seen in any patient receiving this procedure, in which no foreign body is implanted in the cornea. During the healing process, the elliptical, irregular shape of the

head of the cornea tends to become round and regain its regularity. Corneal dioptric power and the thickness of the cornea change as a result of this procedure. In this method of treatment, there is an increase in the thickness and width of the incision site and a change in the nomogram of the cornea and its indices, with its vertical and horizontal meridian releasing steepness tension, resulting in improved visual acuity. Visual acuity improves over time and the improvement depends on the speed at which the incision gap heals.

It is important to note that, during preoperative and postoperative examinations, an inaccurate refractometer reading and an inaccurate astigmatic Pentacam reading are possible as a result of human error. Inaccurate postoperative readings may be obtained because of edema of the eye, which, in my opinion, scatters the light. The refractive error of each eye must therefore be corrected by the examining physician using the duochrome test and the fan test, starting with astigmatic correction and then sphere correction to eliminate human error. Objective

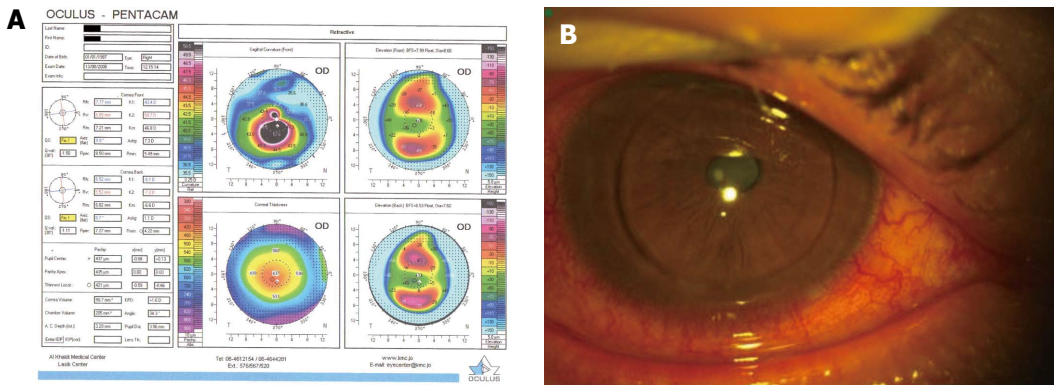


Figure 2 Pre-op Oculus Pentacam tomography. A: Pre-op Oculus Pentacam tomography for the patient's right eye; B: The patient's eye on the day of the surgery immediately after the operation.

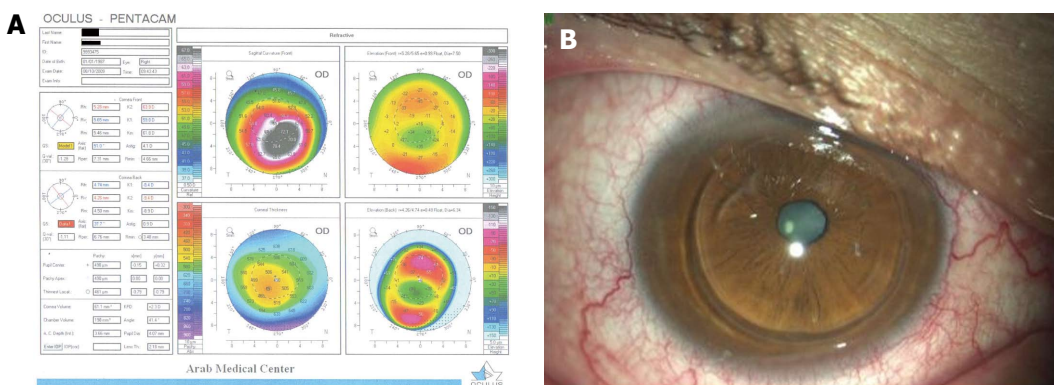


Figure 3 Post-op Pentacam tomography 13 mo after surgery. A: Post-op Pentacam tomography of the same patient's eye almost 13 mo after surgery; B: The same patient's eye 13 mo after surgery.

and subjective tests are essential at this point to obtain accurate readings. As the cornea thickens, its dioptric power changes - the normal range of dioptric power in human eyes is from 43 to 45 diopters^[24]. This dioptric power facilitates proper interpretation of visual stimuli by the visual cortex. In the present study and our research on keratoconus, we found that there is low corneal dioptric power in some areas of the cornea and high dioptric power in other areas of the cornea, as observed by Pentacam Oculus Pentacam tomography. After corneal dioptric power begins to increase, the visual cortex is able to better interpret images received by the eye.

It is our belief that the incisions, due to their unity, sharpness, and regularity, create the basis for the creation of a "tectonic plate" for the production of new stromal cells. Production of these cells continues for an indefinite period, and we have found that cell production is still occurring at the last follow-up but does not continue in all areas of incision. The body will stop the production of new cells once it reaches its genetic capacity, just like a wound or injury to the skin. We believe that, through circular and arcuate keratotomy, we are inducing cell growth in a ring-like pattern. Our findings can be more clearly seen by examining the case of one particular patient.

This patient's readings reflect an approximation of

the mean changes that occurred in the present study. The predetermined surgical plan for this patient was to make paired arcuate keratotomy incisions 2.5 mm from the pupillary axis. The steepest axis was at 10°, the angular length of the arcuate incisions was calculated to be 100°, and the depth for the arcuate incisions was calculated to be 4.4 mm. A circular incision was made 7 mm from the pupillary center and the depth was 5.5 mm (90% of corneal thickness) from 210° to 330° and 4.9 mm in the remaining part (70% of corneal thickness).

Figure 2A shows the preoperative Oculus Pentacam tomography for the patient's right eye and Figure 3A is the postoperative Oculus Pentacam tomography of the same patient's eye almost 13 mo after surgery. Notice the corneal dioptric power and thickness of the cornea from 210° to 330°. The preoperative axis of the eye was at 9.9°. One year after surgery the axis had shifted to 51°. Additionally, the astigmatic power of the cornea front had changed from 7.3 D preoperatively to a postoperative reading of 4.1 D. The astigmatic power of the rear of the cornea was 1.1 D preoperatively and 0.9 D postoperatively.

The corneal volume preoperatively was 50.7 mm³ and after 1 year it was 61.1 mm³. These readings indicate that the cornea's Oculus Pentacam tomography was changing. Figure 2B shows the patient's eye on the day of the

surgery immediately after the operation, and Figure 3B shows the same patient's eye 13 mo after surgery. Clinically, the thickness of the wound appeared to have increased in all areas, with edema and fogginess at the sites of the arcuate and circular incisions. Notice that there was a notch in the left arcuate incision at approximately 160° because of movement by the patient during the procedure. Also notice that the nasal portion was not as thick and some areas had less edema than others.

In conclusions, the results of this study indicate that the Bader procedure is effective and promising in the treatment of stage III and stage IV keratoconus. It is necessary to understand that treatment with the Bader procedure involves a long-term relationship between the doctor and patient because the healing of the cornea occurs as a natural process of the body. There will be many in the scientific community who feel that incision in the cornea increases the potential for rupture. However, there has been no postoperative rupture in any patient who has undergone this procedure. Since arcuate keratotomy is performed after keratoplasty to reduce astigmatism, it makes sense, on the basis of our findings, to consider arcuate keratotomy coupled with modified circular keratotomy as an additional treatment procedure before performing keratoplasty as a final option for correction.

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COMMENTS

Background

To reduce astigmatism, increase corneal volume, and improve visual acuity. In other words, the authors commit actual changes in the ovality of the cornea, by this, the authors reduce the astigmatism, with the formation of new cells, the authors increase the corneal volume in the areas where there is thinning and irregular, when the above achieved the corneal dioptric power changed which enhance a good image to the brain to interpret proper image and registered in the brain.

Research frontiers

Keratoconus is a disease contain the following disorders: (1) Irregularity of the corneal surface from the front and the back; (2) Oval shape of the cornea I mean astigmatism; (3) High myopia due to the invagination of the cornea with forward displacement; and (4) Functional Amlyopia. With Bader Procedure it tends to correct almost the mentioned above.

Innovations and breakthroughs

The Bader Producer is a new way, utilizing the natural process of the cornea to correct it self according to the genetic order of the body in repairing it self without changing or replacing a donor which works as foreign body with the possibility of side effect.

Applications

The authors compare Pre-Op values with Post-Op values, which give the ideas about the improvement occur as a result of the implication done, carrying out another implication could be noticed from the difference of the values.

Peer review

This is a nice and well present case series of patients with keratoconus who underwent paired arcuate and circular keratotomies. The manuscript presents interesting results.

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- 3 **Tian D**, Araki H, Stahl E, Bergelson J, Kreitman M. Signature

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- 4 **Diabetes Prevention Program Research Group**. Hypertension, insulin, and proinsulin in participants with impaired glucose tolerance. *Hypertension* 2002; **40**: 679-686 [PMID: 12411462 PMID:2516377 DOI:10.1161/01.HYP.0000035706.28494.09]

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- 5 **Vallancien G**, Emberton M, Harving N, van Moorselaar RJ; Alf-One Study Group. Sexual dysfunction in 1, 274 European men suffering from lower urinary tract symptoms. *J Urol* 2003; **169**: 2257-2261 [PMID: 12771764 DOI:10.1097/01.ju.0000067940.76090.73]

No author given

- 6 21st century heart solution may have a sting in the tail. *BMJ* 2002; **325**: 184 [PMID: 12142303 DOI:10.1136/bmj.325.7357.184]

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- 7 **Geraud G**, Spierings EL, Keywood C. Tolerability and safety of frovatriptan with short- and long-term use for treatment of migraine and in comparison with sumatriptan. *Headache* 2002; **42** Suppl 2: S93-99 [PMID: 12028325 DOI:10.1046/j.1526-4610.42.s2.7.x]

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- 8 **Banit DM**, Kaufer H, Hartford JM. Intraoperative frozen section analysis in revision total joint arthroplasty. *Clin Orthop Relat Res* 2002; (**401**): 230-238 [PMID: 12151900 DOI:10.1097/00003086-200208000-00026]

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- 9 Outreach: Bringing HIV-positive individuals into care. *HRS-A Careaction* 2002; 1-6 [PMID: 12154804]

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Personal author(s)

- 10 **Sherlock S**, Dooley J. Diseases of the liver and biliary system. 9th ed. Oxford: Blackwell Sci Pub, 1993: 258-296

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- 11 **Lam SK**. Academic investigator's perspectives of medical treatment for peptic ulcer. In: Swabb EA, Azabo S. Ulcer disease: investigation and basis for therapy. New York: Marcel Dekker, 1991: 431-450

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- 12 **Breedlove GK**, Schorfheide AM. Adolescent pregnancy. 2nd ed. Wiczorek RR, editor. White Plains (NY): March of Dimes Education Services, 2001: 20-34

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- 13 **Harnden P**, Joffe JK, Jones WG, editors. Germ cell tumours V. Proceedings of the 5th Germ cell tumours Conference; 2001 Sep 13-15; Leeds, UK. New York: Springer, 2002: 30-56

Conference paper

- 14 **Christensen S**, Oppacher F. An analysis of Koza's computational effort statistic for genetic programming. In: Foster JA, Lutton E, Miller J, Ryan C, Tettamanzi AG, editors. Genetic programming. EuroGP 2002: Proceedings of the 5th European Conference on Genetic Programming; 2002 Apr 3-5; Kinsdale, Ireland. Berlin: Springer, 2002: 182-191

Electronic journal (list all authors)

- 15 Morse SS. Factors in the emergence of infectious diseases. Emerg Infect Dis serial online, 1995-01-03, cited 1996-06-05; 1(1): 24 screens. Available from: URL: <http://www.cdc.gov/ncidod/eid/index.htm>

Patent (list all authors)

- 16 **Pagedas AC**, inventor; Ancel Surgical R&D Inc., assignee. Flexible endoscopic grasping and cutting device and positioning tool assembly. United States patent US 20020103498. 2002 Aug 1

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